TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1877.

VOL. X.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE.

BY

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PREFACE.

The Editor begs to acknowledge assistance afforded by the following gentlemen in revising their papers for this volume:—viz., Messrs. Carruthers, Higginson, Buller, Newman, Skey, and Travers. Most of the proofs of Mr. Kirk's papers were also corrected by him, while Mr. Stack corrected his map and genealogies, and Mr. Cockburn-Hood sent his paper in print with corrections marked thereon.

The paper on the Botany of New Zealand, by Mr. Kirk, which appears in the Appendix, was reserved by the author for completion, on receipt of certain works of reference, until too late for insertion in its proper place in the volume.

The thanks of the Board are due to Mr. Gore for the preparation of the usual Meteorological Abstracts in advance of the annual statistics, and to Mr. Buchanan, draftsman, and Mr. Deveril, of the photo-lithographic department, for their valuable assistance in the illustration of the volume; and to Mr. Earle, who, by permission of the Hon. the Colonial Secretary, was allowed to print the plates at the Government lithographic establishment.

Attention has to be drawn to the fact that, subsequent to the publication of Volume IX., a supplement to that volume was published in July, containing the Proceedings for that year, and an Appendix containing several important papers that had been held over.

ADDENDA ET CORRIGENDA.

PAGE

9, line 15, *after* question *insert* ;

9, line 16, *for* ice ; *read* ice,

12, line 11 from bottom, *for* there *read* then.

16, line 8, *for* there *read* these.

57, line 16 from bottom, *for* Peta Te Hone *read* Pita Te Hori.

57, line 7 from bottom, *for* Mararoa *read* Maiharoa.

57, line 6 from bottom, *for* Natanawhira *read* Natanahira.

69, line 19 from bottom, *for* for *read* from.

72, line 9 (and elsewhere), *for* Kane *read* Kaue.

75, line 13, *for* Te Whai *read* Tetewhai.

79, line 17 from bottom, *for* Ngaitaka *read* Ngaitara.

84, line 13, *for* Te Kapuwai *read* To Rapuwai.

84, line 16 from below, *omit* "

86, line 8 from below, *for* Browny *read* Browning's.

88, In quotation, *for* her involved, *read* him involved.

91, line 14 from bottom, *for* To *read* Io.

105, line 10, *after* settling *insert* on.

116, line 13 from bottom, *for* Le Maine *read* Le Maire.

123, line 3 from bottom (and elsewhere), *for* kumera *read* kumara.

126, line 17, *after* off *insert* to.

129, line 4, *for* Te Kuku *read* Te Koukou

152, line 3, *for* mohopatahi *read* mohopatatai.

213, In first footnote, *for* VII. *read* VI.

CONTENTS.

TRANSACTIONS.

I.—Miscellaneous.

II.—Zoology.

III.—Botany.

NEW ZEALAND INSTITUTE.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

APPENDIX.

LIST OF PLATES.

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND, INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

ABSTRACTS OF RULES AND STATUTES.

Gazetted in the "New Zealand Gazette," 9 March, 1868.

Section I.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act 1867," unless such Society shall consist of not less than twenty-five Members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the Members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such Members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

Regulations regarding Publications.

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled, "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(*c.*) Papers so rejected will be returned to the Society before which they were read.

(*d.*) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(*e.*) Each Incorporated Society will be entitled to receive a *proportional* number of copies of the proceedings and transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

Section II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions:—

(*a.*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

SECTION III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

SECTION IV.

OF DATE 23RD SEPTEMBER, 1870.

Honorary Members.

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies; but inasmuch as such Honorary Members would not thereby become Members of the New Zealand Institute, and whereas it is expedient to make provision for the Election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each Incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year one person, not residing in the Colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated, the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION
WELLINGTON PHILOSOPHICAL SOCIETY	10th June, 1868.
AUCKLAND INSTITUTE	10th June, 1868.
PHILOSOPHICAL INSTITUTE OF CANTERBURY	22nd October, 1868.
OTAGO INSTITUTE	18th October, 1869.
NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY	23rd Sept., 1870.
WESTLAND INSTITUTE	21st December, 1874.
HAWKE BAY PHILOSOPHICAL INSTITUTE	31st March, 1875.

WELLINGTON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1877 :—*President*—W. T. L. Travers, F.L.S. ; *Vice-Presidents*—T. Kirk, F.L.S., J. Carruthers, M.Inst. C.E. ; *Council*—Dr. Buller, C.M.G., F.L.S., C. C. Graham, James Hector, C.M.G., M.D., F.R.S., Hon. W. B. D. Mantell, F.G.S., J. C. Crawford, F.G.S., A. K. Newman, M.B., M.R.C.P., C. Rous Marten, F.R.G.S., F.M.S. ; *Auditor*—Arthur Baker ; *Secretary and Treasurer*—R. B. Gore.

OFFICE-BEARERS FOR 1878 :—*President*—Thomas Kirk, F.L.S. ; *Vice-Presidents*—J. Carruthers, M.Inst. C.E., A. K. Newman, M.B., M.R.C.P. ; *Council*—James Hector, C.M.G., M.D., F.R.S., J. C. Crawford, F.G.S., W. T. L. Travers, F.L.S., Dr. Buller, C.M.G., F.L.S., C. Rous Marten, F.R.G.S., F.M.S., F. W. A. Skae, M.D., F.R.C.S.E., Martin Chapman ; *Auditor*—Arthur Baker ; *Secretary and Treasurer*—R. B. Gore.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the General Meetings of Members of the Society shall be fixed by the Council and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1877:—*President*—R. C. Barstow, Esq., R.M.; *Council*—J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, J. Goodall, C.E., The Hon. Col. Haultain, T. Heale, G. M. Mitford, J. A. Pond, Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, C.E., The Hon. F. Whitaker; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.; *Auditor*—T. Macffarlane.

Office-bearers for 1878:—*President*—T. Heale; *Council*—R. C. Barstow, Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, The Hon. Col. Haultain, G. M. Mitford, J. A. Pond, The Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, M.Inst.C.E., F. Whitaker; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute, shall be proposed in writing by two members, and shall be ballotted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea, the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become life members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the Third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1877:—*President*—Dr. von Haast, Ph.D., F.R.S.; *Vice-presidents*—Dr. Powell, Professor Bickerton, F.C.S.; *Council*—Rev. J. W. Stack, Rev. Charles Fraser, R. W. Fereday, Dr. J. S. Coward, G. W. Hall, Professor Cook; *Hon. Treasurer*—J. Inglis; *Hon. Secretary*—J. S. Guthrie.

Office-bearers for 1878:—*President*—Professor von Haast, F.R.S.; *Vice-presidents*—Rev. J. W. Stack, Professor Cook; *Council*—Professor Bickerton, Dr Powell, W. M. Maskell, R. W. Fereday, Dr. Coward, G. W. Hall; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—J. S. Guthrie.

Extracts from the Rules of the Philosophical Institute of Canterbury.

7. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

25. Members of the Institute shall pay two guineas for the first year of membership, and one guinea annually thereafter, as a subscription to the funds of the Institute.

27. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO INSTITUTE.

Office-bearers for 1877:—*President*—The Right Rev. Bishop Nevill; *Vice-presidents*—R. Gillies and W. N. Blair; *Council*—Dr. Millen Coughtrey, H. Skey, J. S. Webb, G. M. Thomson, P. Thomson, D. Petrie, Dr. Hocken; *Hon. Secretary and Hon. Treasurer*—Professor Hutton; *Auditor*—A. D. Lubecki.

Office-bearers for 1878:—*President*—W. N. Blair, C.E.; *Vice-presidents*—Professor Hutton, W. Arthur, C.E.; *Council*—Professor Shand, G. Joachim, Professor Macgregor, Professor Scott, D. Petrie, E. Elliott, J. C. Thomson; *Hon. Sec.*—G. M. Thomson; *Hon Treasurer*—H. Skey; *Auditor*—A. D. Lubecki.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Council or Society by two members, on payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life members by one payment of ten pounds and ten shillings, in lieu of future annual subscriptions.

8. An Annual General Meeting of the members of the Society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time, until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

Office-bearers for 1878:—*President*—The Right Rev. the Bishop of Nelson; *Council*—A. S. Atkinson, Leonard Boor, M.R.C.S., Charles Hunter-Brown, F. W. Irvine, M.D., Joseph Shepherd, Geo. Williams, M.D.; *Hon. Treasurer and Hon. Secretary*—T. Mackay, C.E.

Extracts from the Rules of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of members elected by ballot, who have been proposed at a monthly meeting of the Society, and elected at the ensuing meeting.

3. Each member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary Meetings held on the first Wednesday in each month.

WESTLAND INSTITUTE.

Office-bearers for 1877 :—*President*—His Honour Judge Weston ; *Vice-president*—R. C. Reid ; *Council*—Rev. W. A. Pascoe, M.A., Rev. G. W. Russell, Rev. G. Morice, Rev. Father Martin, J. Plaisted, L. G. Reid, W. D. Kerr, Robert Paul, J. H. Greville, D. Osborne, Dr. M'Donald, Robert Walker ; *Hon. Treasurer*—E. T. Robinson ; *Hon. Secretary*—Charles Ulrich.

Office-bearers for 1878 :—*President*—His Honour Judge Weston ; *Vice-president*—Robert C. Reid ; *Council*—Rev. Father Martin, Rev. George Morice, Rev. G. W. Russell, Rev. W. H. Elton, John Plaisted, E. T. Robinson, Dr. James, D. McDonald, R. W. Wade, H. L. Robinson, W. D. Kerr, G. A. Paterson, Robert Walker ; *Hon. Treasurer*—W. A. Spence ; *Hon. Secretary*—John Anderson.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist :—(1.) Of life members, *i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards; or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting. (2) Of members who pay two pounds two shillings each year. (3) Of members paying smaller sums—not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1877 :—*President*—His Honour J. D. Ormond ; *Vice-president*—The Right Rev. the Bishop of Waiapu ; *Council*—W. Colenso, J. M. Gibbes, H. R. Holder, S. Locke, J. A. Smith, W. I. Spencer, F. W. C. Sturm ; *Hon. Secretary and Treasurer*—W. Colenso.

Office-bearers for 1878 :—*President*—The Hon. J. D. Ormond, M.H.R. ; *Vice-president*—Robert Stuart ; *Council*—Messrs. Holder, Kinross, Miller, Newton, Smith, Spencer, Colenso ; *Hon. Secretary and Treasurer*—W. Colenso ; *Auditor*—T. K. Newton.

Extracts from the Rules of the Hawke Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance, on the first day of January in every year.

4. Members may at any time become life members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke Bay Philosophical Institute shall be during the winter months from May to October, both inclusive ; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1877.

I.—MISCELLANEOUS.

Art. I.—*New Zealand a Post-glacial Centre of Creation.* By T. H. Cockburn-Hood, F.G.S.

[*Read before the Wellington Philosophical Society, 9th December,* 1876.]

Captain Hutton, in a paper which appears in the last volume of the "Transactions of the N.Z. Institute," has shown that the presumed cause of the shrinking of the glaciers of the New Zealand Alps to their present from their ancient colossal dimensions, is more than "a shrewd guess," and that the examination of its former and existing littoral marine fauna, goes far to prove that it was due—not to a change of climate during a period of Southern Polar Glaciation—but to the diminished elevation of that cordillera, combined with other influences, of which presently. He concludes his remarks with the following observation, "the evidences seem to be in favour of there never having been a Glacial Epoch in New Zealand, and consequently none in the Southern Hemisphere:" that is to say, that there never was a period when a general ice-cap covered these islands as it does the greater part of Greenland to-day, and as so many deem it an established fact that, pressing down from polar regions, a well nigh universal one overwhelmed the whole of nearly both hemispheres in post-pliocene times—against part of which theory New Zealand may be deemed to present very strong evidence.

The term "glacial" is a most convenient one by which to designate those periods of intense cold to which, in their turn, various portions of existing lands are now, and have in all time past been subjected from local causes which admit of explanation, as well as from others affecting broad belts stretching, now in one meridian, now in another, towards the tropics, which may hereafter be understood.

It is therefore to be regretted that it has come to be so commonly applied to this one particular era of assumed change in the temperature of the whole globe, that several writers use the terms Pre-glacial and Pliocene as synonymous, even when the consideration of their readers is being directed by them to New Zealand.

This supposed frigid epoch in the earth's history may well, however, be taken as a fresh starting point by those naturalists who agree with Professor Haëckel, in his proposition that during the "*Glacial Epoch between these vast lifeless ice continents there remained only a narrow zone to which the life of the organic world had to withdraw.*"*

Where this oasis was exactly situated, "the seed of our coming, the seed of food, the seed of man," as the Polynesians describe their Hawaiiki, is not suggested, but it may not unfairly be presumed to have been in that portion of the globe where survivors of its most ancient denizens remain, the certainly unglaciated regions of Australasia. The southern ranges of Australia proper may come to have their local glacial period by-and-bye. Already heavy snows and avalanches do their work there, and fragments of rock have been carried down now and again from their summits, and deposited as *blocs perchés* on the sides of the sub-alpine valleys; but no traces of ancient ice action are to be seen. During comparatively recent times on the contrary, there are many evidences that a more equably warm climate prevailed; in the extra tropical portion of the great island continent the extremes became more severe, as the extensive remnants of the inland sea gradually dried up. We find the remains of crocodiles in the river alluviums, 800 miles south of the present range of these animals, in juxta-position with those of the great extinct marsupials; the tropical marine fauna of its northern coasts had also a wider range, and lingered long in the gulfs of the South Australian sea; the set of the currents was probably from north to south, and species unknown on the eastern coast flourished in these mediterranean waters.

It is an old conservative country this Australia—not given to abrupt changes—but now, like other lands in the southern hemisphere, is gradually rising, especially its central regions. In the Great Australian Bight the upheaval is estimated at as much as twelve feet in places since 1825. Earthquakes are frequent, as in other lands undergoing a similar process, but their effects are little felt on the eastern coast, although evidences of elevation in modern times are found from Cape Howe all along the shores far to the north. The shocks usually are not smart enough to produce visible consequences; not even to shake the trees on the slopes of

* Hist. of Creation, Vol. I., p. 315.

the mountain gorges sufficiently to cause them to drop their winter-gained loads; "Piscium et summo genus hæsit ulmo," may in the glens under Mount Kosciusko be translated, the oxen remained in the lofty gum-trees.

Very frequently when the accumulations of snow after severe winters disappear under the summer sun, cattle are found fixed in the branches of the tall trees in the narrow, deep ravines, filled up with drifted snows, in which they sank—which may readily be imagined, seeing that these drifts are sometimes 800 yards deep—in the upper gorges of the Indi river, as stated in the account given by my venerable friend the Rev. W. B. Clarke, F.R.S., who, with so much care and arduous labour, explored these wild and difficult regions. There are no evidences whatever, nevertheless, of their having gone through a colder period than the present. The view may be taken that this, one of the oldest of existing lands—part of it is as ancient as old New Zealand, of which but little remains—was an independent "centre of creation" in which the progress of development has not in its prevailing forms of life advanced beyond that point reached elsewhere in early geological eras. In this island continent "we find ourselves at home" with our earliest ancestors, "the beaked animals," the *Ornithorhynchus* and the *Echidna;* here are to be seen, hopping about, our somewhat nearer ones the rat-like marsupials, similar to those of the early tertiary epoch, our *certain* progenitors of the seventeenth stage or generation. We have always known that man was made of the dust of the earth, but through what forms that dust had previously passed, we had not been precisely informed until now. It may be satisfactory to many to have their *proved* pedigree put before them by Professor Haëckel, at all events many noble families will feel assured that it is at least as correct and authentic as that of their modern ancestors placed before their fellows in the pages of some genealogical dictionaries.

As well as on the land, individuals of very antique aspect yet linger also near its shores and in its rivers: the *Trigonia* and *Cestracion* of mesozoic days, and that strange creature of most ancient lineage the Devonian-looking *Ceratodus.* It may be urged that these are but examples of the persistent recurrence of peculiar forms under the obligation of the law which governs the process of evolution; or it may be held that they present instances of the tendency to revert under the potency of the same law, circumstances being suitable, to original types even after the lapse of untold ages. Six-legged cats, dogs and other creatures with such abnormal characteristics, are alleged even by some to be merely extreme cases of atavism—*i.e.*, to show clearly the derivation of the mammalia from, or at least their common genetic origin with the *Myriapoda*, and their alliance to the ivy and other clasping plants.

Under certain circumstances, as Sir Charles Lyell says, the great Enaliosaurians might re-appear in the ocean depths and their dragon-like congeners invade the lands, and soar above the forests, for from whence they came, from whom descended, there are no records to tell.

They appeared on earth when cosmical conditions were suitable, and disappeared utterly, it is presumed, when these were changed, leaving no transitional links behind that we know of.

In the present century thousands are ready to accept any new idea, however preposterous, propounded by the class who come under the denomination of "advanced thinkers," who so often evince utter contempt for the axiom of Mr. Huxley himself, that "the first duty of a hypothesis is to be intelligible."

It seems strange, nevertheless, that so startling a one as this Narrow Zone, walled round with solid ice, the withdrawal for thousands of years of solar heat from the greater portion of the globe, when the vivifying rays had ceased to warm the seas, and ocean circulation came to a stand—for this must be the inference—should be accepted with more readiness than the idea of the Noachian Deluge; when, according to Cuvier, there remained only "*Narrow regions, from which man re-peopled the earth after those stupendous events which closed the Elephantine period.*" Those events which took place when the long, slowly sinking Equatorial Continent—the Lhanka of the Brahmins, the Lemuria of modern savans, a map of which is placed before us by Professor Haëckel, where he says man was developed from perfected apes, *a hundred thousand years ago, in Pliocene times*, perhaps *hundreds of thousands in Miocene*, was at last suddenly submerged, during a period of intense volcanic activity, when its foundations were taken away, and other regions were upheaved in its place.

This cataclysmal catastrophe in consonance with Mosaic history, in consonance with the traditions of men of all races, Caucasian, Mongolian, Polynesian, or Negroid, presents none of the extraordinary difficulties which surround the Glacial Hypothesis as thus put before us.

It was a catastrophe affecting a limited area, enormous as compared with that which subsided during the earthquakes of 1819.—The Runn of Cutch, from similar causes acting upon an infinitely smaller scale than they once did in the adjacent regions—but small when contrasted with that over which we are told life was extinguished by a universal ice-cap. The general order of things when the portion of the world known to the advanced families of men, possibly to all the human race, was overwhelmed by the sea, still went on undisturbed, it may be presumed, elsewhere. The giant sloths and armadillos may have moved about on the savannahs of South America, and the great marsupials—the gigantic wombats, kangaroos,

and dasyures over those of Australia; the moas and other wingless birds flourished in the then more extensive land of New Zealand, and the levels under the Rocky Mountains afforded sustenance to herds of mighty animals still, as well as the South African table-lands.

It seems a remarkable fact in the history of organic life, that whilst so many of the contemporary animals have succumbed under various influences during the lapse of time, these great birds of New Zealand should have continued to exist from far earlier ages still until very recent years (if indeed there are not individuals yet remaining), and is probably due to the persistence of an equable climate prevailing over a land in which they had no competitors.

The struggle for life must, as the author of the "History of Creation" admits, have been severe indeed—"fearful," as he remarks—for all forms of tropical fauna and flora especially; hemmed in on a narrow zone between two icy walls stretching nearly from pole to pole, the climate for them must have been rigorous in the extreme. There was in this crowded place of refuge, to which he observes all those wise creatures withdrew "who wished to escape being frozen," an excellent opportunity afforded for the extinction of many nearly effete tribes, and the survival of the fittest; it certainly appears to have been an inconvenient time for man to have begun to push his way—100,000 years ago, Herr Haeckel's date for *pliocene* men, being the great ice age according to Sir Charles Lyell. Unless development has proceeded since with more rapid strides than this writer assumes with his master it did during previous geological eras, primæval men must have witnessed strange scenes.

The migration of the survivors, leaving in many cases no representatives behind them, is a difficult problem to solve,—the wingless birds to their special island habitats; the rodents of South America to theirs, leaving the monotremes and marsupials in sole possession of their ancestral domains.

Without incurring the risk of being deemed deserving of the contemptuous indignation poured upon those "old stagers grown grey in opposite views" who, with "ridiculous arrogance," object under these difficult circumstances to receive the whole theory of descent as enunciated, and the correct pedigrees as offered by so eminent an authority and adventurous a thinker as the author of this history, we may be permitted to ask for some explanation of the formidable objections that stand in the way of our believing in this narrow zone amidst universal ice. The generality of persons who may read his work will scarcely be satisfied by his assurance that "proofs demanded are needless."

One of the first difficulties that suggests itself in the consideration of this particular dogma, this narrow zone to which organic life had to withdraw in post-pliocene times—is that during this epoch, which it appears was subsequent to, if not coincident with, the time when men first commenced to talk sense in Lemuria—*i.e.*, 100,000 years ago—although the circulation of the equatorial currents must have ceased, the chilled waters from both polar regions continued their course with increased force, until they had invaded all submarine depths, and all forms of organic life unable to adapt themselves to the change, or unable to reach the place of refuge, perished.

It would be difficult, however, to prove that polar marine currents have ever operated over greater areas or with more force than they do to-day, and frost now stretches its rigid winding sheet over tracts of land not long since, geologically speaking, teeming with animal life and covered with luxuriant vegetation, whilst in the same latitudes it has relaxed its grasp over others which for ages had been locked in its stern embrace.

Ever varying in their direction during the lapse of years, mighty ocean streams have borne along their islands of ice loaded with the débris of rocks from glaciated regions, strewing the ocean floor as liberally now as in any previous era, dropping boulders to-day upon beds being laid down at the bottom of the sea, to be the chalk hills of future continents, and at still greater abysmal depths of red clay (both composed of exuviæ of minute organisms, falling to the bottom incessantly through countless centuries; a discovery the more astonishing when it is considered that this lifeless red clay, identically the same as that of the dry land so familiar to us, and so long a profound mystery, is seemingly chiefly derived from the insoluble residue of these *Foraminifera*, which is estimated at about only two per cent.) changing the climates of adjacent lands, and causing ever varying migrations of their fauna and flora, as well as of the life beneath the waters, in all time past.

The glaciers in present elevated regions, the Cordilleras of South America and New Zealand, the Himalayas, the Alps, the Caucasus, may not be greater than those which descended from the lofty mountains, higher perhaps than any of these that rose above the plains covered with the forests of the carboniferous era.

Under the pluvial conditions which then probably obtained, judging from the climates in which analogous vegetation flourishes at the present time, we may conclude they are not. At all events the marks of ice-action are to be seen, proving that in those days, as well as in our own, certain portions of the earth's surface had their share of glaciation, however much the general aspect of the fauna and flora may suggest that the temperature

of the globe was at that epoch more equable, if not universally higher, which may reasonably be presumed to have been the case; more especially if, as it has been suggested, climatic zones did not exist until the commencement of the tertiary era.

The further careful observations are extended and ice-marks sought for, where they ought to be found in the same latitudes, if the ice-cap covered one hemisphere in all meridians at the same time, the less strong appears the evidence of the struggle for life, it is alleged that animals and plants underwent in the limited unglaciated regions proposed to have remained during one portion of the quaternary period; a struggle which proved too great for many pre-existing forms, and led to their extinction, as some of the advocates of recurring eras of universal glaciation assert most probably effected the destruction of the giant Saurians, once the domineering tenants of land and sea in all parts of the world; whether that tenancy was altogether synchronous in both hemispheres is an interesting question if its expiry was due to an age of ice; it may well be doubted whether it was.

So far as observations have been made in the southern hemisphere, there are no records of a greater amount of frost than inscribes its marks to-day. South Georgia, in latitude 54° S., is frequently referred to as an evidence of what local influences may bring about in the way of glaciation; exposed to the full force of the berg-laden antarctic current it is wrapped in snow and ice nearly to the water's edge all the year, whilst fifteen degrees to the west forests of beech and fuchsia clothe the sides of the mountains, and humming-birds flit over the glaciers in the Straits of Magellan.

The condition of this island and of Sandwich Island is "a warning," Sir Charles Lyell says, against concluding that glaciation must have been universal over one hemisphere at the same time. The opinion expressed by Professor Agassiz and others respecting the apparent work of ice in the Amazon Valley may nevertheless be correct. A berg-bearing current may have swept over the submerged eastern plains of South America, and the temperature lowered over a broad belt in that meridian; whilst Australia, New Zealand, and South Africa were subjected to no such influence.

The work that is being done by southern currents now must equal in magnitude that performed by the ocean streams which deposited the northern drift, now in one now in another meridian, over the submerged lands of Europe and America. Flowing up to the north, they carry their chilled waters under tropical seas whose surface temperature is 80° to 85°, not only up to the equator, but on, it has been most unexpectedly discovered, into the temperate zone as far as the Bay of Biscay—working, of course, great changes in the submarine inhabitants of vast areas—as similar currents have been doing in all time past, as the great underset flowed

alternately to or from the north, introducing antarctic fauna into the northern hemisphere during one cycle, and arctic at another into the southern temperate zone. Their respective remains, intermingled at first in the upper strata with those of tropical and sub-tropical forms, are now being deposited layer upon layer over the beds which contain such different ones below, and which will again in many places come to entomb the shells and the bones of races similar in type to those which previously there found a grave, when such a change in temperature as has occurred in most regions over and over again takes place.

The most enthusiastic glacialist could ask for no mightier engine than the great antarctic stream bearing its vast islands of ice sixty miles and more in length far towards the tropics in certain meridians.

What local influences are doing now in northern regions, students have more ample opportunity of observing. Notably the condition of great part of Greenland, where, in latitude 70°, ice islands of enormous dimensions float off from a sea-cliff of solid glacier ice 3,000 feet in height. The state of things obtaining in that great land may be contrasted with that in the equally misnamed country, Iceland, even that of its lower portions in 65° N. with that of Lapland in 72°. The climate of the Crimea affords a useful example when compared with that of Venice or Bordeaux. In consequence of the radiation from the Thibetan steppes, we find cereals ripening on the Siberian side of the Himalaya at a height above the sea equal to that of the summit of Mont Blanc, whilst several thousand feet lower down arctic cold prevails, and mighty glaciers do their work above the burning plains of Hindostan, growing under the soft breath of the rain-bearing southerly winds.

Again intense cold prevails over countries on the shores of that great inlet of the North Pacific which, in not very remôte times, teemed with animal life of southern types.

In that region where the Amoor river after flowing amidst umbrageous groves and vine-clad hills turns north and enters a frozen sea, a local glacial period has possibly commenced, advancing with slow but unwavering steps, which might easily be accelerated by the subsidence of the shallow sea-bottom which interrupts the flow of polar waters; whilst in other places owing to a deviation in the direction of local currents of warm and chilled waters in seas of no great depth, sub-tropical forms are again multiplying where but recently arctic ones usurped possession.

The iron grasp of frost has loosened its hold over great part of Western America, and a temperate climate for ages has been gaining sway over the arid regions where rivers flow in deep chasms or canons worn by them through the plains under the Rocky Mountains.

There has been no ice work going on there since the Colorado began to cut its mighty drain a mile and a quarter deep, where it is at the same time but one hundred and eighty feet across; the three hundred feet of the lowest portion of this extraordinary chasm being eroded through hard granite. When this great work commenced, according to reasonable calculations, the northern currents must have been spreading drift on the submerged eastern plains, if that operation went on during the glacial period of Sir Charles Lyell.

The moraines of ancient local glaciers may be seen on the slopes of these mountains below 39° N. latitude, and also upon those of the Sierra Nevada, still nearer to the tropics, but traces of general glaciation there or of northern drift on the shores of California of the same age as that on the eastern side of the Missouri have not hitherto been observed. The vast accumulations of shingle on the terraces of Oregon and Washington territory are as ancient, according to American geologists, as those of the highest plateau of the prairies east of the Rocky Mountains, and are composed, as the latter are likewise, of materials of local derivation. They were deposited there when the Cascade Range already presented a formidable wall, and previous to the time when Mount Hood, Mount Rainier, and Shasta, those grand "Lookers-on" of the Pacific Coast, were piled up.

The boulders which lie on these old shingle terraces on the sides of the Willamette and other valleys, and on the shores of Vancouver, may be pointed to as memorials of the "Great Age of Ice," but they cannot be proved to have travelled very far. The grey syenite of which the majority of them consist, is a distinguishing rock of the Cascade Range, from whence glaciers brought them down probably during a local period of cold.

On the Atlantic side of the Mississippi basin, erratics were dropped in certain meridians, as far south as the 37th degree of latitude, when the way was open over the great lake region then submerged to the polar sea, just as they are being now on the American side of the Atlantic, nearer to the tropic than they were at that era.

Ice-polished and striated boulders, floated from afar in distant ages, may lie buried under the soil of the Californian plains, but none have been discovered by American observers. I could see no foreign stones or ancient ice-marks on the slopes of Calaveras or Mariposa, above Yosemite.

There is a vast river in the Pacific coming from equatorial regions, entitled to be described in the same expressive language with which Maury introduces his readers to the consideration of the Gulf Stream. It sweeps near the coast of Japan past Yokohama, leaving the shores of Yesso further off than it does those of Nipon, and has flowed in the same course, tempering its climate and causing hurricanes in its seas, we may conclude from

remotest times, for there are no signs of glaciation in Japan proper.

Although Fusi-Yama (which, according to Japanese tradition, grew in a few days under the eyes of men, as Iorullo did), reared its imposing cone on the sea-board plain, that recently elevated region is but a narrow strip along the shore, and ice-marks ought to be seen on the flanks of its main chain of ancient hills, if the glacial epoch prevailed over the whole of the northern hemisphere simultaneously. But an intelligent traveller who has lately ridden over the interior of the island from north to south informed me that there were none visible on their eastern side; and the talented author of "Frost and Fire"—Mr. Campbell—has sought there also in vain for any testimony of the rocks to the continued reign of the first, whose signs are so familiar to him.

A deflection of the Pacific or Japan stream which flows on past the Kurile Islands, curving round by the Aleutian chain to the coasts of Oregon, causing a rainfall there nearly equal to that of Darjeeling in the Himalayas, would bring ice over the terraced gardens on the slopes of the "Matchless Mountain," and over the whole of Yesso; opposite the northern shores of which for many miles off the land, the sea is frozen every winter, in the latitude of Naples, in consequence of their being swept by that current which, escaping through narrow portals, flows round into the Yellow Sea, chilling the coasts of China. The British colony of Vancouver and Washington Territory, instead of being enveloped in fogs, would be reduced to the condition in which Britain itself was when no Gulf Stream came near its shores, and to which Greenland has been brought in recent times.

There not very long ago the oak grew, and animals throve where ice-streams now flow, and there was a time still more remote when the magnolia blossomed and the vine clung to giant sequoias in its forests; and there may be another not so very far distant when the magnetic current (which may be the cause that produces this intense cold) may vary its direction and go further east again, and the eastern branch of the Gulf Stream may flow inside of Iceland; there Norway and Scandinavia will again have their age of ice, whilst the "lost land" may once more merit its now inappropriate name and be covered with green woods. It may be when the present Arctic Expedition returns, evidences will be produced of semi-tropical vegetation having flourished in still higher latitudes again at later geological eras than when the carboniferous vegetation prepared the material for the coal of high northern regions. Such a discovery as that the Pole itself is now situated in the centre of a land, in former ages covered with umbrageous forests, would clash violently with existing theories. * * *

Every process of evolution may, of course, be more readily conceived to be possible by assigning unlimited time for its performance. But if the

elaboration of new species, by the "aimless action of Natural Selection," necessitates the granting of thirty times the number of millions of years physical considerations render it possible to allow, as Dr. Tait states the question, the difficulty of the position will not be lessened by Herr Haëckel's bold assertion, that "we have not a single rational ground for conceiving the time requisite to be limited in any way."

This writer, although he deems very slow progress to have been the rule, leaves his readers to believe in the possibility of exceptions to it. Notwithstanding the small advances made during the recent period in any line of life (how the cats, the dogs, and the pigeons of the days of the earliest Pharoahs remain represented but by pure cats and dogs and pigeons still, not one attempt at passing beyond the limit of its class having been made by any of these creatures, whose development has received such attention and studied assistance from man), they are not to be daunted by the proposition that in new centres of creation, such as New Zealand, the derivative process was by some means marvellously hastened in its accomplishment.

Recurring periods of heat and cold extending simultaneously over the greater part of the world, may be convenient agents to call into requisition for the purpose of explaining the disappearance of many forms of organic life. The vanishing of others for a time, and their return to the same localities, displacing very different ones that in the interim had flourished there, is, no doubt, due to such cause. But had these cycles been repeated more frequently than even according to the views of Mr. Croll they have been—views much more within our grasp than the consideration of processes requiring œons paralyzing to the minds of most men who attempt to dwell upon them—they would not account for many of the events which we know have taken place in the history of animal life.

Ten thousand or twenty thousand years may be deemed by evolutionists generally, periods altogether too short for the accomplishment of any of the processes of divergence and development necessary to the establishment of species, for which millions have been asked; but much could be done during such a vast lapse of years in the way of perfecting various families and the extinction of others. The recurring periods of the reign of frost over particular areas in alternate hemispheres, which have evidently taken place, would cause no violent changes, advancing as they must have done with slow enough steps to afford ample opportunity for the migration of existing forms of life to suitable situations, so long as any such remained for them to migrate to, which during this Glacial Epoch of Professor Haëckel were certainly reduced to a minimum.

There was no ice-sheet enveloping their ancient haunts, which destroyed

the Diprotodon, the Zygomaturus, and Nototherium, in the marshy savannahs of Australia, but as these became drained in the course of the gradual elevation of the land and converted into arid plains, swept by sirocco-like winds, the succulent vegetation upon which they lived failed, we may presume, and remaining represented by related animals of comparatively pigmy size, they disappeared utterly as the Megatherium, the Megalonyx, and Mylodon of South America, which likewise leaving small analogues behind, passed from the face of the earth under the influence of some such cause, or destroyed by the irresistible attacks of internal parasites, (as we see hosts of domestic animals now throughout extensive districts of Australia, unable to resist the enemies which had proved less dangerous to the indigenous marsupials, from whom they were derived), or of swarms of pestiferous insects, such as the tsetse fly of Africa, or the calf- and foal-murdering one of Patagonia.*

It will not be proposed that any change of temperature destroyed the aboriginal horse of North and South America. Herds of these animals roamed in comparatively recent times from the cold north to the Patagonian plains, and their contemporaries flourish there still. Whatever was the cause of their extinction, it had ceased to act when the Spaniards conquered Mexico, for the new equine race introduced by them has multiplied rapidly, and continues to flourish equally well in a feral as in a domestic state. When the plague or the cholera take their tens of thousands of men, the lower animals remain generally unscathed, and *vice-versâ.*

The parasitical worms which are so fatal to the flocks of the Australian sheep-farmer abound in the kangaroo and wallabi, and the former, if left to themselves, would ere long become extinct, destroyed in some districts by the parasites, in others starved out by the increasing hordes of hardy marsupials. The increase of this inferior order of animals as it stands in the derivative pedigree has been immense since the balance was destroyed by the extinction of the dingo, and since the aboriginal men have so much decreased in numbers. Thirty thousand kangaroos of large and smaller tribes have lately been killed on a single settler's run without making any observable diminution in their strength, and until some epidemic arises amongst them, their singularly rapid increase will tax the efforts of the white man to check in these thinly peopled regions. If these marsupials are so inferior a grade of animals, they are at all events admirably adapted for the situation they now occupy; so peculiarly well adapted to it that after

* An interesting circumstance of this kind is now being observed over large districts in the interior of New South Wales, which, if it continued, would lead in time to the disappearance of white cattle and white-legged or piebald horses in the herds, such being attacked by a disease caused by a black *Aphis* covering the pastures, producing fatal effects upon all young animals, and even many grown ones, whilst those whose coats are of dark colours do not suffer at all.

the enormous length of time they have occupied it, not the slightest attempt of divergence is manifested, and apparently as during the untold ages of the secondary era, they are destined to remain *in statu quô*, so long as the present circumstances obtain. It seems as unsafe to hazard any theory upon their inferiority and adaptability to vary as upon beauty being due to sexual selection, seeing that the most perfect beauty is possessed by certain organic forms which have no organs of perception at all.

The disastrous effects of the ravages of insects in the vegetable world are familiar, and the power of the canker-worm and the palmer-worm to change the character and climate of extensive regions is not a modern discovery. Forests of mighty trees that have withstood the battle and the breeze of centuries, whose hardihood and tenacity of life is great enough to enable them to survive the scorching and charring of their trunks by the fires that sweep again and again through the jungles, quickly succumb under the repeated attacks of myriads of seemingly despicable foes. In consequence of the extraordinary increase of a species of moth, innumerable armies of caterpillars for one or two consecutive seasons devoured the leaves of the red gum-trees in the grand forests of Gippsland, amongst the finest in New Holland, and now the weird skeletons of these, the loftiest trees, some of them, in the world, mar the landscape. For another half century or more, they will remain as memorials of what was once the condition of the shadeless plains, the extent of which men are ruthlessly increasing daily, over which the winds coming off the sea, that heretofore had kept this an Australian Eden, will cease to part with their refreshing showers, as they once did over the "rain-bringing" trees, and will carry their burthen on to the cool mountain slopes.

The upheaval of the central region of Australia has been alluded to. The process goes on, and what is taking place in New Holland, New Zealand, South America, and doubtless in Antarctic regions may be perhaps taken as evidence of the balance of weight becoming in favour of the northern polar ones; those who adopt this theory will deem it strengthened if instead of an open polar sea, it is found that they are covered with ever growing mountains of ice.

The violence of the volcanic action in the far south is felt in the convulsive throes that disturb distant places, and which cause ever and anon a more rapid flow of the great covering of ice, sending off vaster streams of bergs than during periods of rest. The earthquake waves which notified the disturbance in 1868, were certainly followed by such a fleet.

It may be said that a considerable portion of Scandinavia is also rising; this may be a local consequence of the subsidence of a parallel belt of the adjacent ocean bottom, a meridional folding of the crust of the earth, as Mr. Campbell suggests.

Ere many centuries have passed away it may be that the remnants of the ancient shallow sea, marked on the map of Australia as Lake Torrens, Lake Éyrę, Lake Gardiner, etc.—which, with their margins of black, fetid mud, supporting scattered tufts of salsolaceous plants, resemble the salt lakes of Siberia and Patagonia, regions which were also in recent times raised from beneath the sea—will be silted up and then drained, the climate will be still drier and subject to greater extremes of diurnal temperature, remarkable as there are now in the interior as far as 18° S. latitude. The Barcoo or Thomson river will cut a canal-like channel through the sandhills to the head of Spencer's Gulf as the Darling has done further east. The surplus waters, after the periodical deluges of rain in the tropical country from which they flow, spread out over vast areas of the central depression, and already during very high floods find an outlet from Lake Torrens at Port Augusta, where the land is estimated to have risen seven feet since the first survey of that harbour was made.

The change in this region from a mediterranean sea to arid plains (where, notwithstanding the 10° difference in temperature between places in the southern and those in corresponding latitudes in the northern hemisphere generally, the heat from various causes is much greater than in the African deserts in similar parallels) must have exercised a most potent influence upon the climate of New Zealand and the adjacent oceanic regions, as it does to a considerable extent to-day, when alternate cycles of wet and dry seasons prevail over these great levels, now torrid deserts, and at other times in great part covered with water; an influence not very greatly inferior to that which the drying of the Sahara must have produced upon the climate of Europe, and the dimensions of the Alpine glaciers. When that desert region which now, "like an immense furnace," distributes its heat around over distant lands, was covered by the sea, and a large portion of Europe was likewise submerged, over which came berg-laden arctic currents, it may well be conceived that the higher elevation of its central chain of mountains, estimated by Professor Ramsay to have been from two to three thousand feet at the time their glaciers attained such colossal demensions, was sufficient to produce all the phenomena attributed to a general age of ice, which may come to be proved to a great extent, should the project of letting the sea into the great depression of the African Desert be carried out.

There may be grounds for supposing an ice-sheet of vast extent to have covered great portion of Northern Europe, Asia, and America, at or about the same era, but evidence of its having been universal is wanting even in the northern hemisphere, and any evidence of an approaching similar state of things in the southern is sought for in vain.

The "Glacial Epoch" in New Zealand is assumed by Dr. Haast, F.R.S., to have been synchronous with the alleged period of the general reign of frost in northern regions, and we are accustomed to hear of the "PLEISTOCENE GLACIERS" as those which have done the most work in the land of the moa. But there seem to be very good reasons for placing the age of their greatest extension back in pliocene times, about the time man was learning experience in Lemuria.

When the Cordillera stood at an equally higher altitude as that claimed by Professor Ramsay for the Swiss Alps, we may be well satisfied with the ability of the rain-bearing winds coming round in their sweep back from equatorial regions over the warm Australian Sea to breed glaciers of magnitude sufficient to do all the work claimed for them—to shape the sides of the valleys and glens, scoop out the basins of the southern lakes, grind out the fiords of the west coast, and break up and collect the materials for the formation of the sub-alpine plains, to be spread out there by the torrential rivers in after times, which, as the land has gradually risen again after partial submergence since, have left the remarkable terraces, whose symmetrical lines produce such a striking feature in the landscape—of magnitude sufficient to carry off masses of rock 20,000 tons in weight, if required, and deposit them as *blocs perchés* below, with as much ease as those masses of Mont Blanc granite were borne along and left on the sides of the Rhone valley. Which operation probably they did perform, but the memorials being of less durable material, have disappeared under the gradual wear and tear of ages, or lie buried under the accumulations of gravel and sand on the plains, or beneath the sea.

In both of these mountain systems, as in the Himalaya, changes in the dimensions of their ice-streams, and debacles caused by the bursting of glacier dams, from time to time occur, on an insignificant scale it is true, when compared with what we may well believe went on in the days of their greatest grandeur, from local causes apparently, but which causes owe their origin to events going on in far distant regions. It is convenient sometimes to compare small things with great, and the operations proceeding quietly now, enable a judgment to be formed as to how the same causes, working with more activity, might readily be able to repeat the phenomena that engage so much attention.

The glaciers in the Swiss Alps, which had been retreating for thirty years, are advancing again at present, those descending from the heights of Monte Rosa are tearing up the green fields and overwhelming the gardens and homes of the peasantry, and, as the alternate advance and retreat of those of Mount Cook and adjacent mountains, present an evidence of the effect of ocean currents upon regions apparently far removed from their influence.

For some years previous to 1872, the antarctic stream came loaded with huge islands of ice, to an extent not witnessed by mariners since the route round Cape Horn became so frequented a highway as it has been since the gold discoveries.

Navigation in those seas was for a time so extremely perilous that insurance companies became alarmed, and many shipmasters sent their vessels to struggle back against the westerly winds by the Cape of Good Hope. Another great separation of bergs from their parent glaciers, an occurrence which has no doubt gone on intermittently in all ages, happened in 1829, as related by Sir Charles Lyell. Then, as in these late years, many bergs retained the dimensions of islands when they had reached the longitude of the Cape of Good Hope; some had nearly circumnavigated the globe before they foundered in Australian seas, and one was still many miles in length when seen off Cape Leuwin. An excellent opportunity was afforded for the conveyance of seeds of the same plants if any are produced or remain possessed of vitality in the soil of the lands from which they came, to different places in their route, a possibility dwelt upon by Mr. Darwin, in alluding to the sprinkling of the same flora in far distant regions; it seems probable that had the climate been suitable, plants now unknown there might have by this means been brought far up into Australia when the land was lower, as there is evidence of bergs having been drifted up in former times high into Spencer's Gulf, on the shores of which large boulders of foreign rocks have been left by them. There are no data as yet upon which to found a theory as to the periodicity of these occurrences, which might connect the action of the main-spring which sets the machinery in motion, with any of the many causes, magnetic, sidereal, etc., which have been proposed as influencing alternating cycles of dry and wet seasons—such as the return of Biela's comet every six and a half years—the time of the solar spots every eleven—the twelve-year cycle supposed to have to do with the long one of the revolution of the planet Jupiter, etc., etc. However this may be, there is every reason for believing that when polar winds are more than usually chilled over certain oceanic areas, they will blow with more force, and mingling with other aerial currents nearer to the tropics than in ordinary seasons, condense their moisture.

Australian climates would be the principal ones affected by such a cause, so we find that after the great ice-stream alluded to, the following years were wet ones in the then occupied part of New South Wales. Again, in 1869, commenced a cycle of splendid seasons for the farmers all over the Australias, dry plains were converted into lakes, and steamers ascended the tributaries of the Murray more than 1,500 miles. The consequences of the ice-stream were also felt in New Zealand. In

1869 the writer visited the great Tasman Glacier on the eastern flank of Mount Cook, which then, as the Cashmere head of the Indus is represented to do, issued from under the terminal foot of the glacier in one grand foaming fountain, boiling up to a height of 60 to 80 feet, "coming from under an arch, lofty, gloomy and Avernus-like, a large ready-formed river, whose colour was that of the soil collected at its source, rolling along immense masses of ice, and whirling them against the rocks with the noise of distant cannon." Some years previously, when the ice had retreated nearly half a mile, the river issued in two streams from under the lateral moraine on either side of the glacier. A local glacial period was commencing, the operations of which became suspended since the amount of ice borne off by the antarctic current diminished again to its normal quantity, as it has done lately, and dry seasons have returned in Australia threatening ruin to the farmers and graziers.

The more the subject is considered, and the effects observed of such agencies, the less necessary does it appear to call in the aid of extraordinary ones of which no traces are visible.

Had there been a general ice-sheet covering New Zealand, its ancient littoral marine fauna which still exist, its moas, and other apterous birds must all have perished, and whence came again those forms of life from which they were developed? It is scarcely to be conceived that this far island of the sea, situated in the latitude it is, would be proposed to have been included in the narrow zone amidst universal ice, the crowded Alsatia where ape-like men contended with men-like apes and divers other creatures with their respective congeners, in the dire struggle for existence that took place within its limited precincts, when the weakest, the least able to consider and provide against the exigencies of the situation, perished.

It is not enough to have events so stupendous, and others still more startling, declared to have taken place at distances of time so enormous that the consideration of them leaves but an indefinite impression upon the mind, merely stated as facts, and related with an air of acknowledged authenticity, as the stories of the reign of Henry VIII., by Mr. Froude.

Instead of engaging the attention of enquirers or allaying their scruples, such facetious proposals are scarcely even calculated to afford as much amusement as the extension of Mr. Darwin's paradox, in the allusion to the correlation of old maids, mice, and roast beef.

In his anxiety to prove the non-miraculous origin of the universe and all things therein, Professor Haeckel assumes a tone of contemptuous pity towards those persons who refuse to profess their absolute faith in the irrational dogma that the primordial forms were endowed with life and the power of propagation of their own instance. Considering that "what we

call spirit disappears with the dissolution of the individual material combination," as another of the teachers who have risen up amongst us puts it, content to believe himself a mere accidental aggregation of particles of carbonic acid, water, and ammonia, possessing nothing the lowest animal does not share, having no future its progeny may not attain to, he treats with scorn those who attribute the wonders of creation to "*the much talked-of purpose in nature*," to their having been, as he expresses it, "*invented and constructed for his amusement by an ingenious Creator*," whereas they have "*in reality arisen from the aimless action of natural selection*."

Whilst propounding his views about the narrow zone to which those creatures wise enough to object to being frozen withdrew, he appears to have forgotten the postulate with which he commenced; to have lost sight of the fact that this aimless action of natural selection must be deemed a myth, that the whole theory of descent, as Mr. Darwin himself says, must fall to the ground, if one fatal case is proved of a number of species having suddenly started into life all at once.

If ever any theory demanded in its fullest import the acceptance of that old canon in natural history, quoted by his great master, "*Natura non facit saltum*," that of the gradual progress of organic life requires it to be acknowledged as its most inexorable law—a law as immutable as that which produces the unchanging forms assumed by certain substances in the process of crystallization.

When the problem comes to be considered how life began again in isolated oceanic regions, such as New Zealand, when this terrible *annus mirabilis* had passed by, and the ice had retreated from the sequestered shores; those who believe in the preliminaries, in the universal ice-cap, in the scheme of the evolution of species, so ably, so seductively some may prefer to say, proposed by Mr. Darwin in his attractive pages, and so confidently asserted by his adventurous disciples, who respect no limits recognized by their master, find themselves face to face with a difficulty of which no explanation is vouchsafed.

It was difficult enough to imagine any solution that seemed to afford an escape from the dilemma those were placed in who accepted Dr. Haast's ideas regarding the pleistocene glaciation of New Zealand. He does not appear however to assume that the ice-sheet he would draw over these islands was universal over the southern hemisphere, and may consider that there were regions near where life was not extinguished, and from which their lacertian progenitors might have made their way and founded the families of the apterous birds—if such be their descent—without commencing *de novo* the whole process of evolution from some simple ancestor.

Accepting even the proposition of the spontaneous generation of the

primordial form, whenever required—granting the possibility of the coming into existence of a body containing an inner principle of life, some mysterious force—that Mr. Bastian's experiments but prove that every atom of what chemists deem dead matter, is pregnant with the power of self-development, merely held in a state of utmost tension, from which it is ready to spring forward into life, when chance is given—discharging from their minds any such "emotional sensation" as the process being in obedience to a creative power—the believers in this place of refuge amidst the ice have to solve the problem how it came to pass that the progeny of the primordial form went through all the stages, which required thousands of millions of years, according to his own teaching, to accomplish before, so successfully in the new centre of creation, New Zealand.

How the gigantic birds were quickly elaborated from their reptilian progenitors, and these from theirs during the brief space of the post-glacial age. If time is necessary for any important process of evolution, it must have been for this supposed wonderful transformation of the cold-blooded, solid-boned, scale-covered lizard, into the hot-blooded, hollow-boned, feathered birds, and the latter have certainly flourished in high perfection in New Zealand it will be admitted from most remote times.

We know from the history of Australia, during late geological ages, that the ancestors of the moas could not have migrated from thence. The connection between New Zealand and the north-east of New Holland, New Guinea, Celebes, the Aru Islands, and other small marsupial strongholds, portions once of the ancient bird-inhabited Pacific Continent, was severed in a far distant era, when the marsupial line of life had not perhaps advanced beyond the assumed stage of its batrachian infancy.

In that old land of Oceanica, or Apteryxia we may designate it, the lizard race had already far risen in the scale of being, and if the pedigree be true, some tribes of their feathered descendants had colonized its north-eastern regions, where their representatives remain to this day; one family especially having held its ground well. The emu was not to disappear before the new marsupials any more than its analogue in South America, which probably tells us of a more ancient story still in the history of land and sea; the cassowary also has remained in tropical Australia, although the nearer ally of the *Dinornis*, its rival in size, whose remains have been discovered by the Rev. Mr. Clarke, F.R.S., had not been able to continue its race. On the mountain tops of the submerged continent, representatives of its most ancient denizens also survive. New Britain, New Ireland, and Ceram have their cassowaries as well as New Holland and New Guinea, and the great southern peninsula was in complete possession of the grandest specimens of the ornithic race for long ages after its separation by a wide sea

from the nearest portion of the ancient land, as Madagascar remained, no doubt, also for long ages, the happy home of the *Æpyornis* after Lemuria went down.

But if ignoring these considerations which seem to make the history of New Zealand certain, as that of the other large insular countries mentioned, and all the many old islands of the sea, to whose venerable story Mr. Wallace says, fearlessly, their inhabitants give us the key; if disregarding the absence of all evidence of its ever having been covered with an ice-cap, and that there is no possible reason for alleging it to be a logical conclusion that it must have been so covered, the glacial enthusiasts will risk their belief in all things else, so long as they can picture to their minds this island in the sea of ice, where all was war and carnage; if, instead of the moas being the long descended representatives of a royal race of birds, come from one of the most ancient aboriginal families upon earth, they deem them mere creatures of yesterday, modern adventurers, it is clear that they must be prepared to admit that their advancement must have been most improperly rapid.

Their lacertilian forefathers, and theirs before them, must have been addicted to saltatory practices more daring than those of our *proved* American cousin, that strange Mexican batrachian the irrepressible axolotl; and have set at defiance the old established laws of slow progressive development followed in all other epochs, as laid down emphatically in the Theory of Descent, endangering the foundations of that edifice, so far as immeasurable time is requisite for the safety of its construction.

Their advance in life must have been far more precipitate than that made by the inhabitants of the Gallapagos, where the frogs or allied batrachian patriarchs have no nobler descendants than the lizard and the tortoise, and yet these families can probably trace their descent from ancestors of fair standing in the world, when they first landed on the scarce cooled lavas. Gay sea-going lacertians, and slumbering chelonians on some floating log may have reached their shores, and from their eggs came the few four-footed creatures domiciled in these islands, amongst them the little altered descendant of one of them, nearly the last of its race, the only marine lizard now known. The ocean depths may however be tenanted still by forms of life we little imagine. Or, notwithstanding the antipathy the batrachian race evince to being cooped up in isolated regions, the Gallapagos population may have a more ancient local pedigree, and be descended from the survivors of a shower of young frogs. The distance is not too great to suppose the possibility of their having been caught up in some strong revolving storm from an American pool and carried thus far; it is not long since a number of these creatures were

landed in excellent health and spirits on the deck of a vessel in the Pacific, half that distance from the Australian coast.

If such a fortunate chance occurred, which, however, is scarce possible, and gave a somewhat fairer start to the higher forms of life in New Zealand, their offspring have devoured the race of their ancestors, as until very recently frogs were unknown there; now introduced from Australia in some localities they croak from every pond their appreciation of its swamps, safe from destroying snakes. Touching these same frogs, it appears to have been a want of judgment in their various descendants, a blunder justifying the term of "the aimless action of natural selection," not to have gone on improving and perfecting the attributes possessed by them. None of their progeny being able to jump about and avoid obstacles in their path after the connection between the brain and limbs has been severed, one would imagine that the course of progressive development should have improved, instead of arresting the advantageous capacity enjoyed by some of their analogues and remote progenitors of producing new limbs, and even heads, when accident removes the original ones.

On the whole most persons will prefer to consider the moas the long descended aboriginal inhabitants of this land where they have reigned lords amongst wingless birds from the far distant era when it formed a portion of a great continent, which on the score of antiquity has equal right to be delineated on the map of the old world as Lemuria.

All that is now land has been sea, and the seas land, not once, but probably over, and over, and over again, and as a continuity of the various dry portions of the globe has at one time or another existed (excepting, of course, new lands like the Gallapagos and other volcano-born isles), the ancient connection explains how it came to pass that wingless birds descended from the same original created type are found in South America, in Africa, and in all these islands of the sea.

It seems easier to believe in the tertiary men, who might if they desired, have gone to war mounted on Anchitheriums (for we may be permitted to take for granted that there may have been a family of these creatures large enough to carry their short-legged, ape-like riders), who were there to witness, we are told, the coming upon the stage of the elephantine races, and all the many quaint-looking giant creatures, long passed away, than to imagine that their descendants could have been present at the birth of the first taniwha-descended, post-glacial moa.

Certainly the supporters of this idea may suggest that some of the tertiary men devoted themselves during the long pliocene ages (which, when it suits his argument, are reduced to moderate periods by Professor Haeckel), to the breeding of birds without wings, and achieved in the pursuit success

equal to that of Mr. Bakewell and Mr. Booth in increasing the size and modifying the forms of their herds; and that their remote descendants, not having lost the art, commenced a moa farm in this island of the Pacific, having brought with them a basket of eggs from Hawaiiki or Lemuria.

Art. II.—*On Mill's Fourth Fundamental Theorem respecting Capital.*

By John Carruthers, M. Inst. C.E.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

In John Stuart Mill's "Principles of Political Economy" wealth is defined to be "*all useful or agreeable things which possess exchangeable value;*" capital is defined to be "*a stock previously accumulated of the products of former labour.*" (Preliminary Remarks, p. 6, People's Edition, 1869.)

These definitions are almost the same, as scarcely anything possesses exchangeable value except the products of former labour.

Natural productions which can be and have been appropriated, are useful and have exchangeable value; they are, therefore, by the definition, wealth; but as they are not the product of former labour they are not capital. The natural grasses on the Canterbury plains, for instance, are wealth but not capital; artificial grasses in the same field are both wealth and capital.

Monopolies are also wealth but not capital; they are useful to the owner, and are exchangeable for commodities, but are not the product of former labour.

With these two exceptions, everything defined by the one word is also defined by the other; that is, capital is an accumulated stock of the products of former labour, and wealth is the same thing with monopolies added; for the sole right to the use of land or of any other free gift of nature, is only a monopoly.

When thus stated the necessity of a radical change in the definition of one or both words becomes apparent.

I propose to define wealth to be "everything in the world which is useful or agreeable to man;" and capital to be the "ownership of that wealth."

This definition of capital would require some limitation in order to bring it more nearly into accordance with the usual meaning of the word, but for my present purpose it is not necessary to be more minute, more especially as by doing so my paper would reach to an unwieldy length.

Health, strength, education, mechanical skill, and all other useful personal gifts and acquirements are wealth, and every free man is a capitalist to the extent of owning his own personal powers of body and mind. The health, strength, skill and intelligence of a slave are, however, as far as they are transferable, part of his master's capital.

The sun's warmth and light, air, rain, land, and all other useful natural agents are wealth. Where they cannot be appropriated by any individual, the ownership is common to all, and all are capitalists; where they have been appropriated, as in the case of land, the owner becomes the sole capitalist as regards them.

The wealth of the world consists of natural agents which we receive unconditionally; of our personal mental and bodily acquirements; and of wealth which has been produced by the labour of man to eke out the supply that nature has unconditionally given, and which is not sufficient for our subsistence. This last we may call "commodities."

The stock of commodities in the world is perpetually being consumed and replaced by others produced by the unceasing labour of man. It is like the sea, from which the sun is perpetually taking away, but to which all that is taken away is returned by the rivers after it has passed over and fertilised the land. But for this circle of evaporation and rainfall, the earth would be a sterile waste; but for the circle of consumption and production, man would be reduced to a state no better than that of the brutes.

Our stock of commodities would not keep us alive more than two or three years at the furthest, and if labour ceased, that short time would see the almost total extinction of civilised man. "The accumulated wealth of centuries" is a thing of imagination. All the commodities in the world, which were not produced by the present generation, would not, even if converted by miracle into bread, at their exchange value as compared with that of bread, give us a single good meal. Accumulated capital there may be; that is, some families may increase, in every generation, their ownership of the wealth produced by others, but this can only be done to a small extent; the capital of all the banks in England represents but a very small part of the wealth which the labour of Englishmen produces every year.

It is not important to any individual in what form his capital may be. He may hold cash, or land, or he may have a stock of commodities in his store which would be of no use to himself, if he could not exchange them; but, by the help of trade, his capital will give him whatever form of exchangeable wealth he may wish. Practically, he is not the owner of any particular commodity but of a share, proportioned to his capital, of all the commodities of the world.

Commodities which are removed from the circle of consumption and reproduction practically cease to be wealth, and their owner to be a capitalist. A steam-engine which is not at work might as well be in the moon for all the usefulness to man which it possesses, and the owner gets no benefit from it. If instead of a steam-engine, a stock of food and clothing is stored up, it is also lost to the world; the selfish owner may live on it for years, but when it is consumed he has no more capital. Had he given his stock to workmen, on condition that they should work for him, he would have done them good, by furnishing them with food, and his stock of wealth would have been larger than ever, for labour can, under ordinary conditions, produce more than the labourers consume when producing it. Such a man is a miser in the truest meaning of the word; fortunately, no one does store up actual wealth in this way; if hoarded at all, it is always converted into capital in the form of gold, and the storing of gold does no injury to the community. The hoarder loses a revenue which he might have had, but which he generously leaves to be divided between all his brother money-owners throughout the world.

The "*actual cost*" of a commodity may be said to be the labour which has been expended in producing it, including a proportionate part of that which had been expended in making the tools used in its production. If the commodity be made in an out-of-the-way place, the extra labour employed in conveying to the workmen, the food, clothing, and other things they consume, should also be added, the food itself, however, and the other things, or rather the labour of producing them should not be added, nor the labour equal to that necessary to convey them to people not living in an out-of-the-way place, for they would have been consumed in any case, or if not, it would not be because the workmen were idle, but because they were not capitalists.

The "*proper cost*" of a commodity is the actual cost it would take, under fairly judicious direction, to produce a similar commodity or a different one which would be equally, and in the same manner, agreeable or useful to man. A chemist may spend great labour in digging minerals from the earth and extracting from them hydrogen and oxygen, and in making these combine to form water. The "actual cost" of the water thus produced would be the labour expended by the chemist; the "proper cost" would be the labour required to draw a bucket of water from the spring.

A disregard of this obvious distinction has cost, and is still costing the world very dearly, in false political economy, and is the root of half the popular errors in the theory of money.

There are so few commodities of which the actual and proper cost are greatly different that it is forgotten that they can be different.

All writers on Political Economy call money wealth. By Mill's definition, and also by that which I have suggested, it is so. It is something useful, as an implement of commerce, and possesses exchangeable value. By my definitions it would also be called a commodity, but it is a commodity of which the actual cost is great and the proper cost is nothing. If the several nations composing the community who use gold and silver as a medium of exchange, passed a law that in future these should not be money but that certain printed pieces of paper should take their place, and that after the present holders of money had been presented with one of those pieces of paper in exchange for each sovereign he possessed, no more should be printed except a small defined number to be printed annually in order to cover expected losses and to meet the expected increased demand due to increased commerce, we should have a new commodity costing nearly nothing and which would possess all the useful qualities possessed by money.

Metallic money is in fact like the water made by the chemist, a costly commodity, which is useful in the same manner, and only to the same degree, as another commodity which costs nothing.

It is not more wise to use gold as a medium of exchange, where paper would do as well, and to employ an army of skilful, intelligent, and enterprising workmen to dig it out of the ground, than it would be to employ the same men in quarrying minerals containing oxygen and hydrogen, and then to hire a chemist to mint them into water for household use, while, at the same time, a river was passing the doors. Whether wise or not, still it is done. Workmen are employed digging gold; when a man gets a nugget, he is entitled, by long established custom, to be rewarded by a tax, levied on the whole world, proportioned to the weight of the nugget. He has no trouble in levying this tax; he simply takes his nugget to a capitalist, who gives him such commodities in exchange for it as the miner may choose, and the nugget thenceforward, whether coined into money or not, is a token certifying that the bearer has paid directly, or at second or later hand a tax due by the whole community. Like all debts contracted by the community for unproductive expenditure, this debt is twice paid, or rather is still due although it has been already paid. The finding of the nugget did not increase the total quantity in the world, of those commodities which the miner took in exchange for it. All that he got must therefore have been taken from some one who would otherwise have got them. The consumers of those kinds of commodities, therefore, paid the debt, but they paid it to the manufacturer of the commodities, who got it in the shape of higher prices, instead of to the capitalist who advanced the goods to the miner. The latter was not paid, but the token he held being a con-

venient instrument for passing capital from one man to another, he has no difficulty in disposing of it and it takes its place as a circulating medium.

Money is therefore valuable to the owner in the same way as any other acknowledgment of indebtedness. As a commodity, its proper cost is nothing, but it is a token proving a legal claim to a share of the wealth of others.

Having now explained the definitions which I believe to represent most accurately what wealth and capital really are, as well as the less important ones which it was necessary for the purposes of my paper also to explain, I will proceed to my main work, which is to test the arguments employed by Mill in the 9th part of chap. V. book I. of his "Political Economy," by substituting these definitions for those employed by him. The greater clearness of view which we get will enable us to detect the fallacies which the confusion of his definitions prevented him from seeing.

His fourth fundamental theorem respecting capital may be shortly stated to be, that by purchasing commodities a capitalist is not an employer of labour and does no good to the working classes, but that by keeping retainers, grooms, gardeners, and others working for him, or by giving away his income in alms, he does good to them and tends to raise their rate of wages.

His illustrations are very telling and well selected. A man, he says, may spend part of his income in employing workmen to build houses, dig artificial lakes, and lay out pleasure grounds; or he may spend the same sum in buying velvet and lace. If he has been in the habit of buying velvet and then changes his expenditure to hiring bricklayers, there is, at once, additional work for bricklayers, and the velvet-makers do not lose their employment, for they are employed making corduroy and other things for the bricklayers, so that the work given to the latter is clear gain to the working classes.

He gives several other illustrations, but none, I think, in which the fallacy lies so deeply hidden as in the one I have selected. At first sight his argument looks unanswerable, but it is really quite erroneous.

There is in the world a certain store of commodities, part of which is suitable to the wants of the rich, and part to those of the poor. The capitalist may select which of these he will take for his share, but he cannot turn velvet into corduroy, nor Chateau Lafitte into gin. The proportions of these which have been produced have been decided by men whose occupation and interest it is to estimate, as closely as they can, the quantity of each that will be required, and any sudden upsetting of their calculations is pretty certain to do harm. The philanthropic capitalist will find it very difficult to do any immediate good to anyone whom he would care to benefit,

except at the expense of the very class whose well-being he wishes to promote.

If he does not buy the velvet which was manufactured in the expectation that he would buy it, velvet will fall in price, the manufacturer will lose money, and the wealthy classes who wear velvet having more of it to divide between them will each get more; that is, they will pocket the money the manufacturer lost.

Not having bought velvet, the capitalist has money to spare, and, in accordance with his kind intentions, he lays it out in corduroy and other commodities which the working classes use. These he distributes, as a gift, to people who, but for his bounty, would have had to go without them. Surely he is now doing good? He certainly is doing good to those who receive these good things, but all they get is taken from those who, if he had not interfered, would have got them; that is, the rest of the working classes, for whose use the commodities were manufactured. Our philanthropist's benevolence has, in fact, been paid for solely and entirely by the working classes. The capital he has parted with has gone bodily into the pocket of the corduroy manufacturer, who has been made happy by the rise in prices created by the unexpected and unprovided for demand. This is always the result of spasmodic benevolence; the working man pays for it.

The half million of money which has just been sent to India, or rather the wealth which is represented by it, came entirely from the poorer classes. The rich gave money which passed undiminished into the pockets of the grain merchants. Their alms did not reduce the quantity of bread they eat; they perhaps bought less velvet, thus benefiting those still richer, who did not require to retrench even in their consumption of velvet; but the real privation was borne by the labouring men, from whose stock all the grain was taken which was sent to feed the starving ryots.

If a rich man wishes to share his wealth, after it has once been produced, with the poor, he must give them that which he would otherwise have used himself; he must let them walk in his garden and eat the fruit and pluck the flowers; he must take them drives in his carriage; give them velvet to wear which would otherwise have decked his wife; share his Chateau Lafitte with them, in short he must really be self-sacrificing; if he gives them that which was manufactured for the use of others, he is only using his wealth so as to compel other people to do good to the objects of his compassion.

A capitalist has no power over the past, but he has over the future. Let us see how his endeavours to do good will be rewarded the second year.

The velvet-maker finding the demand for velvet slack will not pro-

duce so much next time, indeed, having lost part of his capital, he has not the command of the same quantity of commodities to give his workmen as he had before, so he is obliged to dismiss some of them, and would, therefore, not be able to produce so much, even if he wished to. The corduroy maker having, however, made money, and finding the demand for his wares brisk, employs more men and produces more corduroy. The total employment given by the two manufacturers together is therefore the same, and no injury to the working class has been produced by the mere transfer of capital from one of them to the other, no wealth in short has been lost or destroyed. There will be next year more corduroy made and less velvet. Our philanthropist has succeeded in doing good to the working classes to this extent; so long as he continues his bounty it is at his own expense and not at that of others. The rich man's charity, however, seldom or never does good; it generally returns into the pockets of the rich, and does so in this case, for his bounty is so much saved in poor rates to the neighbouring gentry.

If he tries Mill's other expedient of employing labour in building houses (not, however, for the poor to live in), in digging artificial lakes, and in making pleasure gardens, his success will be if possible still smaller. The self-sacrifice shown in making a personal display of wealth by having a fine garden instead of by wearing velvet is not of the kind that does much good to anyone.

We will assume that after having made his annual purchase of velvet, he resolves that in future he will be an employer of labour, and, to simplify the question, that he has told the velvet-maker of his intentions, so that the latter does not make so much velvet but employs his wealth in some other way. Under his old style of proceeding his income would have been accumulating until the velvet which he was about to buy was manufactured and until the requisite sum had been got together. It would probably have been placed in the bank as it came in, and the bank would have taken good care that it was not left there lying idle. It would have been lent out to manufacturers who would have procured with the money the wealth it gave them a right to, and this wealth would have been given to workmen in exchange for their labour, which would be devoted to some profitable employment in producing new wealth to replace that which they consumed. This must now stop, the philanthropist wants his money from day to day to pay his gardeners, so the manufacturer's labourers are thrown out of work, the manufacturer not having means to pay them. The gardeners, however, get the commodities which the manufacturer's men got before, and so on the average no harm is done. There has been a transfer of work from manufacturer's men to gardeners, and the labouring classes neither gain nor lose.

The wealth which has been produced to replace that consumed by all the workmen concerned is also much the same as if no change had taken place in our philanthropist's expenditure. Had no such change taken place there would have been employed a certain number of velvet makers whose produce would have been quite useless to the working classes. There would also have been employed an equal number of manufacturers' men, whose produce might or might not have been useful, according to their employment.

The change having taken place, there are employed the same number of gardeners, whose produce is nil, also the same number of velvet-makers who, having been thrown out of employment, have taken to some other trade, where their produce, like that of the manufacturer, may or may not be useful to workmen.

The nett results of these endeavours to do good are—when charity is tried, a reduction in the poor rates; when keeping retainers is tried, a slight derangement of trade.

As to the theorem itself, the illustration of which we have now discussed, it is partly a truism, partly an error.

It will perhaps be best to examine separately the two sentences of which it is composed.* "*What supports and employs productive labour is the capital expended in setting it to work, and not the demand of purchasers for the produce of the labour, when completed.*" In other words, the labourer is supported by the food and other things he gets while at work, and this food is part of the food at the time in the world. This, of course, is a truism. The velvet-weaver is supported by the food he gets, and if he got no food he would make no velvet, however strong the demand for velvet might be.

"*Demand for commodities is not demand for labour. The demand for commodities determines in what particular branch of production the labour and capital shall be employed; it determines the* direction *of the labour; but not the more or less of the labour itself, or of the maintenance or payment of the labour. These depend on the amount of the capital, or other funds directly devoted to the sustenance and remuneration of labour.*" This sentence is very confused. The capitalist's own demand for commodities is the only cause of the employment of labour. The demand of others may decide the direction of that labour. A farmer, for instance, of a backwoods farm in Canada, with his stock of potatoes and pork, is a capitalist. He knows that his stock will soon be exhausted, and therefore labours to replace it. He consumes his present stock, not for the purpose of renewing it, but to keep himself alive. His own demand for commodities is the sole cause of his labour, and it gives also the direction of his labour. He meets the demand by growing more potatoes and pork. If he has neighbours who can produce

*Part 9, Chap. V., Book I., p. 49, People's Ed., 1869.

these commodities better than he can, he will grow wheat or something else for which they have a demand, in the hope of trading with them. His produce will then depend for its direction on their demand. All other capitalists are influenced by the same motives. They know that their stock, however ample, will not last long; they therefore labour to replace it; if they can, they get others to help them, and, as an inducement, let these others share their present stock. All trade is founded on this simple principle.

Mill, like Ricardo before him, has got confused by giving to the word capital, which means the ownership of wealth, the definition which should be given only to wealth. He uses the word sometimes in the usual—sometimes in the defined sense.

The velvet-maker has a capital which he employs in making velvet; here "capital" means wealth. He gives his wealth to the weavers who help him to make the velvet, and thus to renew his stock of wealth. Again, the velvet-buyer has a capital which he devotes to buying the velvet. Here "capital" means not wealth, but the ownership of wealth; a right to a share of the wealth produced in the world, which share is taken in the form of velvet. The velvet-maker does not want velvet for himself; like the farmer, he produces things he does not want, so as, by trade, to get the things he does want. His own demand for commodities has made him work, and his neighbours' demand for velvet has given the direction to his work.

There has been only one portion of wealth employed in making the velvet, that of the velvet-maker. The wealth of the velvet-buyer has been employed about something else. He also has been making something he did not want, so that he could get what he did want, which was velvet. Mill's arguments are founded on the erroneous supposition that there were two portions of wealth employed about it.

If the velvet-buyer put his money into the bank, as supposed in my illustration, it would have been unnecessary for the velvet-maker to have any capital at all; he could have borrowed it from the bank, and thus the velvet-buyer would have supplied almost directly the commodities which maintained the velvet-weavers while they were at work.

It will thus appear that Mill's fourth theorem is erroneous, and the corollaries he draws from it equally so. If a capitalist spends his wealth in employing retainers of any kind, he does no more good to the working classes than if he spent it by exchanging it for velvet or diamonds.

His own demand for commodities is the only cause that his own stock of wealth is employed in feeding and clothing labourers while they are engaged in producing new wealth. If he does not himself produce the very commodities he wants, it is merely because it is more convenient to

himself to produce others and to obtain those he wants by trade, but it is practically his wealth that is employed in their production.

If a benevolent capitalist wishes to benefit the working classes he cannot do so by giving away his wealth in charity; he only reduces the poor rates and thus benefits his wealthy neighbours. He cannot do so by employing labour in work, the produce of which is not to be enjoyed by the working classes themselves. He has but one path open to him, and that is to devote his wealth to the production of those commodities which labouring men generally use, and to give those commodities to workmen, not in alms, but in exchange for labour, which is to be employed in producing a still larger stock of the same. In other words, he must become a manufacturer and must conduct his business so as to make it pay. If he conducts it so as to lose money he is wasting the wealth entrusted to him and might as well buy velvet at once; the effect on the working classes would be the same.

If he makes money by his business he will become still richer and he must at last get rid of his wealth in some way. How is he to do it? Wealth is like the genius which had to be kept constantly employed or it would destroy its master. Unless it is constantly and properly employed its owner becomes a public enemy, and if it is properly employed it will perpetually increase, and make its owner's responsibility still greater. It is almost impossible to get rid of wealth without doing harm. One way would be to gradually turn it into gold and to throw the gold into the sea. There would be no destruction of wealth more than there would be in throwing so many small pieces of paper away, and even less, for the "proper cost" of gold as a medium of exchange is absolutely nothing; the ownership only of it would be transferred to all other owners of money in the world. This would be therefore giving the wealth principally to the rich, and it would, by increasing the exchange value of gold, be an incentive to further gold mining, a most wasteful expenditure of labour; it would also increase the national debt, and is, on the whole, not to be recommended. Another plan would be to gradually invest it in the national debt and present it to the nation. This would benefit rich and poor and is probably the best means open to a man who having done his share of labour had earned and wished to enjoy the leisure which an old man should have.

A younger man possessed of the requisite energy and knowledge could do still better. He might by engaging lecturers and by other means succeed in impressing on the working classes the vast benefit, even in a merely material way, which education would give to their children, and he might, to some extent, pay the expenses of their education; he might get museums, libraries, and other educational institutions established; forward

science by providing some of the more expensive tools required, and by paying scientific men, so that they might devote more of their time to scientific studies.

He can do none of these things, except at the cost of the working classes; all the wealth devoted to the work would be diverted from the production of material comforts, which, if produced, they would enjoy, and no one has a right to make his poorer fellow-citizens pay for anything, unless he, after careful consideration aided by the best knowledge open to him, is fully convinced that the privation he compels them to suffer is compensated by the advantages they will get in exchange.

It is not too much to say that an expenditure equal to that represented by the national debt of England would be well invested, if it could be made the means of rousing the working classes of England to insist on every one of their children being as well educated as might be done, without throwing any unbearable burthen on the country.

Art. III.—*Observations on the Evidences of recent Change in the Elevation of the Waikato District.* By James Stewart, C.E.

[*Read before the Auckland Institute, 6th December,* 1875.]

That rivers are ever scooping their beds to lower levels, and eroding their banks until new channels are established, are matters of common observation. Considering the immense weight of water in a river like the Waikato, its moderately rapid current, and its course, in the lower parts, through alluvial flats composed of materials of the lightest nature, it is at first sight subject for wonder that the changes are not more rapid than they are. It is, however, true that the lower Waikato cannot now cut its channel very much deeper in a practical view, unless the land is raised, relative to sea level, because a certain definite gradient has to be preserved to carry the water off to sea. But if we suppose the land to be elevated, suddenly or otherwise, a great change would soon be observed in the condition of the river. Falls or rapids would be established at its mouth, which, in more or less time, according to the nature of the bed, would reduce the gradient to what it was before. During the time this was being effected, the increased current would have formed a new channel, sometimes coincident with the old one, but often crossing and recrossing it, until, when the normal level and current had again been established, the old river course would be traceable as a series of lagoons or narrow winding swamps, elevated above the new level of the river, by as much as the land had been raised.

If, again, we suppose a bar of harder formation than the rest of the valley to have existed and which had dammed the waters back; to be reduced by the current, the same kind of changes would take place in the channel above, as we have considered would be effected by the raising of the land, and the amount by which the dam had been lowered would be traceable approximately, in viewing the levels of the old and new channels.

In the lower and middle-Waikato, the features of the country indicate that possibly both these causes have contributed to the changes of the position and levels of the river. At Mangatawhiri the river leaves the sandy alluvial flats and takes westward through the Tuakau Gorge to the sea. If we view the country upwards from thence, we can observe some of the more salient features of the scene. And we find on passing each successive gorge through which the river has, in by-gone ages, cut its way, that the banks are higher than they are below, presenting in the higher reaches three, five, and even seven terraces, each indicative of a level for the time being of the river, or lake-like stream, before these natural dams in the gorges were lowered.

The evidence also that at these ancient river levels, the waters found other routes to the sea, nearly amounts to demonstration. So much for the lowering of the river through the formation of the land. Regarding the country having risen, it is, almost equally beyond doubt, that the sea once washed the bases of the inland hills in the Thames and Waikato valleys. In Vol. III. Art. 25, "Trans. N.Z. Inst.," Mr. Kirk gives a list of littoral plants, some of which he found established one hundred miles inland of the present tidal influence. The natural inference that these plants were left in the salt marshes, formerly at the base of the now far inland hills, by the sea which receded as the land arose, supports the opinion expressed by Dr. Hochstetter, and points to a comparatively recent elevation of the land. It seems clear enough, then, that to both erosion of natural dams, and to an elevation of the country, are to be traced the causes of the river now flowing at from ten to more than one hundred feet (speaking well within the mark) lower than it has formerly done. These estimations being from the sea to the Maungatautari Gorge, to which division the present notes are mainly confined.

The speculative thought to which we are invited by these considerations abounds in interest; but when we find in the midst of alluvial sands, occupying the place where once the ocean rolled, indubitable evidence of the previous subsidence of the whole country, we find the subject increased in complexity, and leading to fields of vast speculative study, which topographers will not soon exhaust. The waters of the river have lowered, or the land has been raised, or both combined. The extent of this we can

see and measure. The land has been submerged, but to what extent we cannot tell. The proofs of this subsidence we at present adduce are two. The first lies in the "sunken forest" of the lower Waikato. This we find at a distance of forty-five or fifty miles from the sea, and there are the remains of an ancient forest, the trunks of whose trees are standing as they grew. The tops of the stumps reach to about mean summer water, and stand about two feet above its lowest level. Hard and dangerous the river captains find them, and much labour has been expended in cutting and mending channels for the navigation. These trees never grew *in* the water. They are of kinds well-known to us as the general forest trees of the present day. The specimen shown is from a "snag" which lately sunk the steamer "Waipa." It is kauri, but nearly all the larger trees now known are also to be found as snags or in positions where their roots are of a certainty far below the level of high water in the ocean. And this forest may have been on an upland plateau, may have crowned the summit of a hill; nothing can with certainty indicate, but the fact remains that this forest was submerged, cut off by fire or decay at the level of the water, and buried under about six feet of pumice sand, through which the broad river now flows. It has at present a tendency to cut into the eastern bank, and in so doing continually unearths other stumps in every way alike to those now standing in the river.

The other proof of subsidence now submitted was discovered only a few weeks ago in sinking cylinders forming the piers of the Waikato Bridge at Ngaruawahia, sixty miles from the sea. The bed of the river there is pumice sand and gravel. A stratum of hard sandy clay underlies this, dipping to the south. Below this is a hard and compact bed of shingle and coarse green-sand without a trace of pumice. The cylinders were sunk into this shingle by the pneumatic system, and reach several feet below extreme low water in Auckland Harbour. It was found to be composed of fragments of clay-slate rock waterworn, but only to the extent of smoothing and well-rounding the corners. On examining Dr. Hochstetter's geological map, we find in the Waikato Valley above this place no indication of such rock nearer than the Kaimanawa Range south of Taupo. But much more adjacent, in the Waipa Valley, Hakarimata Range, lying parallel to and westward of the river, is marked as composed of clay-slates, and it is possible that these stones were torn from the ravines of that range and deposited in the river-bed, which must then have been far above the sea-level. To what depth this shingle deposit extends is not likely to be soon known. It was explored only so far as was necessary to determine its suitability, in nature and position, to carry the bridge. It may have been a mountain torrent high up in a continental range. The subsidence may

be fifty feet or it may be five hundred. The nature and condition of this old river-bed indicates that a strong current and clear water prevailed. When the country sank it must have continued until the sea flowed over the present Thames and Waikato Valleys, and since which time it has receded to its present coast by the re-elevation of the country.

At one time, too, the waters of the middle Waikato rose above the level of the so-called delta. Then were deposited these vast beds of pumice, gravel and sand, bearing evidence of subsequent disturbing upheaval. The present argillaceous ranges were then so many islands, the tops of submerged mountains or hills. In a ravine which, a few years ago, the waters of a shallow swamp in Ngaruawahia worked out of the pumice of that township, are seen the stumps of trees, fifteen feet below the present surface, standing on the rich soil in which they grew. Next we trace a level of the river intermediate between that lacustrine era and the present, when the flats of the delta were left dry, and a new channel, yet clearly traceable, carried the waters for a time, and then were formed most probably the alluvial clay flats of Taupiri Gorge. The current was then too rapid for the deposit of pumice sand, for we only find it in isolated pockets as if deposited by eddies. In the wide-spreading valley below, however, the light and all but floating sand was laid over the whole low country, covering the "sunken forest," and leaving it much as we find it. Another slight rise in the country, and the present aspect of affairs was presented—the river has cut lower through the sands, leaving the swamps of the delta far above its level, and again exposing to our view the "forest."

We have thus attempted to sketch a very shadowy outline of some very momentous changes which have occurred in this part of our island. The details will yet, we hope, be filled in by more able hands, guided by scientific geological knowledge and research.

ART. IV.—*Address.* By Professor JULIUS VON HAAST, Ph.D., F.R.S., President of the Philosophical Institute of Canterbury.

Plate I.

[*Read before the Philosophical Institute of Canterbury, 5th April*, 1877.]

IT has hitherto been the custom that your newly-elected president, when he takes office, should deliver an address to you, in which either a *résumé* of scientific progress during the year is offered to you, or some subject of local bearing is treated more fully. In taking the presidential chair, I shall

gladly conform to this rule, but first I must thank you most sincerely for the honour conferred upon me, and to assure you that I shall endeavour to advance, to the best of my abilities, the interests of our Society, which now has existed about fifteen years, and at the cradle of which I have stood. It was the intention of the Council to have this address delivered at a *conversazione*, to be held, if possible, in the new Museum buildings, but as the Chairman of the Board of Governors of Canterbury College has intimated to a deputation of your Council that it was the intention to open shortly that building with a similar festival, in which it would be desirable to exhibit for the first time a whole series of objects of artistic and scientific interest, which your Council thought could be made available for our anniversary meeting, we have thought it would be better to unite for such an occasion our efforts with those of the Board of Governors, so that the opening ceremony might be of still greater interest. I have no doubt that you will fully agree with this view of your Council, which was only adopted after careful consideration. Instead of passing in review the scientific progress during the last year, as far as the accounts given of it have reached New Zealand, I have thought it more expedient to speak of a few local subjects, of which the remarkable rock paintings in the Weka Pass Ranges, near the Waikari, and of which Mr. T. S. Cousins has made a conscientious copy for the Canterbury Museum, is, without doubt, of the highest interest. I have much pleasure in exhibiting these drawings to-night, as well as another, copied by the Rev. James W. Stack, in the Opihi country. Description of it will be found in Appendix 2 to my address. But, before doing so, I shall treat of two other topics, to the consideration of which we might well devote some of the time at our disposal.

First, I wish to allude to the intra-Mercurial planet Vulcan, the existence of which is more than hypothetical, although it would be very desirable to have this proved beyond a doubt. You are doubtless aware that the great French astronomer, Le Verrier, when occupied with an investigation into the theory of the orbit of Mercury, found that a certain error in the assumed motion of its perihelion could only be accounted for by supposing that the mass of Venus is at least one-tenth greater than it was assumed from the measurements taken, or that there exists some unknown planet or planets between Mercury and the Sun, by which a disturbing action is produced. Le Verrier, without offering an opinion upon these hypotheses, towards the end of 1859 communicated them to the scientific world.

Shortly after this statement had been made, Lescarbault, a French physician living at Orgères, announced that, on March 26th of the same year, he had observed the passage across the sun's disc of what he thought might be a new planet, but had not liked to publish this discovery before he

was able to offer further evidence in confirmation. This statement appeared so important, that Le Verrier went himself to Orgères, and, after examining most carefully the somewhat primitive modes of Lescarbault as to fixing his time and of making his calculations, the great Paris astronomer was convinced of the correctness and importance of the discovery made, and he calculated, from the data given, the approximate elements, of which the following are given in George F. Chambers', F.R.A.S., "Descriptive Astronomy:"—"The inclination of the orbit to the ecliptic, 12° 10′; daily heliocentric motion, 18° 6′; distance from sun's centre, taking the earth's as unity, 0.143, or about 13,000,000 miles; period, 19d. 17h." The application of Kepler's third law, namely—that the squares of the periodic times of the planets are proportional to the cubes of their mean distances, gives a remarkable semblance of truth to Le Verrier's "Elements." On March 20th, 1862, Lummis, in Manchester, observed also what he thought was a planet passing across the sun's disc, but unfortunately he could only continue his observations for twenty minutes, when other duties compelled him to desist.

There are also several other instances known where astronomers have observed a small but well-defined round spot pass over the sun's disc, as, for instance, Fritch, October 10, 1802; Stark, October 9, 1819; Sidebotham, March 12, 1849; Schmidt, October 11, 1847; Decuppis, October 2, 1839; which all have been connected with Lescarbault's planet, and to which the name Vulcan has been provisionally given. The observations of Lummis offered the material to two French astronomers for new calculations of the elements, the results of which are not contradictory to those published by Le Verrier, but appear to confirm them. From the position of the nodes, or those points where the orbit is cut by the ecliptic, it appears that transits over the sun's disc can only be expected between March 25 and April 10 at the descending node, and between September 27 and October 14 at the ascending node. However, on October 2, 1876, and at a subsequent meeting, the French Academy received further communications from Le Verrier, in which, with great lucidity, all material at his command was most carefully revised, and the elements of the new planet were given, the existence of which the French astronomer believes to have been proved.

Le Verrier shows that many solutions can be given according to the value given to an indeterminate in the formula. Several calculations are then offered which, with a possible indeterminate, range from 27.96 to 51.75 days (large errors included) for the orbit. The great French astronomer also calculated the time of conjunction in the intervals 1853–63, 1869–77, and 1885–92, and showed that the transits are regulated by a period of about seventeen years. The transit may be expected in the middle of each of those periods, but not for a number of years afterwards. After having

determined the possibility of any transit in our autumn of this year, Le Verrier came to the conclusion that a transit may be expected on the 22nd of last month, requesting astronomers all over the world to watch for such an important event. Should (unfortunately as far as Australia and New Zealand is concerned) no transit occur on that day, none can be expected before our autumn of 1885. A transit for the opposite nodes (September and October) cannot take place before 1881.

It was, without doubt, with a view to obtain an observation of this expected planet on and near the day calculated by Le Verrier, that the Astronomer Royal sent me a telegram on February 22 to have the sun's disc closely watched on March 21, 22, and 23. And I was much gratified to learn that both in Wellington and Dunedin a close watch has also been kept, which, however, like the observations taken in Christchurch, had not the desired result. Moreover, the telegraph brought us the news from Sydney that also, there, nothing unusual had been observed on the sun's disc, so that, as far as this portion of the southern hemisphere is concerned, this matter can be considered as being settled. However, before we have any news from Europe and America this negative result does not prove that the planet has not been in conjunction with the sun.

The observations in Australia and New Zealand from sunrise to sunset, taking into consideration the difference in longitude, would range over thirteen hours, having also allowed the loss of half-an-hour each morning and evening. Now as, according to calculations made, the transit of this planet across the sun's disc might take about four hours, we can add even three hours for the morning and evening to our time, as in New Zealand the egress in the morning, and in Australia the ingress in the evening, would have been observed, had the beginning or end of the transit taken place within the hours of observation at any of these countries. This would give us about nineteen hours, and consequently there remain about five hours each night during which Vulcan might have passed over the sun's disc at our antipodes.

The observations in Christchurch were made in the private observatory of our member, Mr. James Townsend. This gentleman was assisted by his brother, Mr. William Townsend, and by Professor Cook, Dr. Powell, and myself. A systematic watch was instituted throughout the days of March 21, 22, and 23, for the purpose of observing the face of the sun to detect the appearance of, and passage across, his disc, and also for the measurement and noting the position of any object which might by any probability be a planet, and not an ordinary sun-spot. Although not possessing a photoheliograph, the appliances would have sufficed for the purpose should the almost expected stranger have put in an appearance. They consisted of a

telescope of four and a-half feet focal length and three and a-half inch aperture (by Dallmeyer), mounted upon an equatorial stand, not driven by clock-work, but moveable at an even pace by a tangent screw and handle with Hooke's joint, the eye-piece being furnished with cross spider-web lines; the low magnifying power of 75 being used in order to allow of the projection upon a card-board screen, supported by an easel, of the whole image of the sun's disc, on a scale of about 14 inches diameter. The means of measurement were provided by the passage of the sun's image, by the diurnal motion, along and across the said lines, which were set in the proper position by the passage along the equatorial wire of any marking on the sun's disc—facula or spot. Sidereal seconds could be noted in one direction, and in the other angular intervals by means of the declination circle, and the distances from the margin referred to these co-ordinates, and, by an obvious calculation, to the centre of the sun. The nautical almanac would do the rest. A revolving roof over the telescope-shed, and a shutter the opening of which could be reduced to any required aperture by stops, and a screen attached to the object end of the telescope, served to darken the observatory to any required extent. Watch was kept on March 20, 21, 22, and 23, from sunrise to sunset, by relays of watchers prepared to measure and to draw the appearance of any unusual object. The weather was mostly fine and favourable; the exceptions were on the afternoons of March 21 and 22, from one p.m., when clouds intervened. Desultory observations were also made at frequent intervals for several days before and after the days above cited. But, as before observed, our patience was not rewarded by any discovery, the sun's face being marked only by the general mottled appearance, and by a group of spots travelling towards the north-west margin, leaving a facula to mark the place of disappearance on the 24th, these spots having been first noted on the 18th, near the middle of the disc. A group of faculæ on the south-east border was also noted on the 24th and 25th. Let us hope that the observations in Europe and America will be more successful, so that Vulcan will no longer remain a phantom, but will have joined his wife Venus in the heavens, and both may at last become, what they were said not to have been in ancient classical times, a steady-going couple. Such a happy state of affairs may still more surely be expected, as Mercury, the witty and lively god, whilst going between them, is certain to keep them in order, and at the same time at a respectful distance from each other.

Another subject of which I wish to speak is a question of physical geology, to the elucidation of which, in years past, I have devoted a great deal of thought. However, when I came to the conclusion that I had found its

solution, and scrutinized closely the merits of my explanation, it failed to stand the test of that examination. The question to be solved was the following: You are, without doubt, all aware that the rivers on the Canterbury Plains have the tendency to undermine their banks, consisting of loose fluviatile deposits, on their left or northern side, and that they have done this already so effectually that, in their lower course and for a considerable distance, their right or southern banks are always low, and possess scarcely any terraced appearance, whilst they continue, generally to the very sea-shore, to be fringed on their left banks by a high terrace or cliff. To give only one instance, I wish to point to the Rangitata, where the railway crosses it, and where we have to descend considerably before we can reach the river-bed, which, on the southern side, is only bounded by low ground. It must strike even the casual observer that, whilst the left bank forms, as far as the eye can reach, a high and conspicuous cliff, the right bank is so very low and ill-defined that the river continually changes its course.

With many geologists who had observed similar phenomena in other countries, I had tried to explain this peculiar tendency of our rivers by assuming a small oscillation of this portion of the South Island, the North gradually sinking and the South rising, by which the waters of all the rivers flowing through it would be thrown towards their northern banks; but when I searched for evidence all round Banks Peninsula, or at Timaru and Double Corner, for this supposed partial sinking and rising of the ground, the evidence before me did not warrant such an assumption. Some time ago I found in Professor von Hochstetter's excellent geological hand-book, "Die Erde," reference to a theory first set forth by Carl Ernst von Baer, the eminent physiologist and anatomist, but who was equally distinguished as a physical geographer, by which that peculiar feature of our rivers is fully explained. Although von Baer could only base his theory on the rivers of the northern hemisphere, and then principally upon those of Russia and Western Siberia, it will be seen that it is fully borne out by our own rivers. These latter, moreover, prove the universality of the phenomenon, with the exception, as von Baer prognosticated, that the opposite banks of the rivers in the southern, when compared with the northern hemisphere, would be affected.

It is long ago that the observation was made on several rivers in Europe and Northern Asia, which are enclosed in banks of loose material, that they continually and steadily try to advance towards the right, and that consequently they wash away and undermine their right banks. Many explanations were given, principally (as I had tried with our own rivers) by assuming local changes in the level of the earth's crust; but the generality of the phenomenon made such an explanation impossible.

At last, in 1860, von Baer brought forward his hypothesis that such changes in one particular direction could be only caused by the rotation of the earth, and he explained the *modus operandi* in the following manner :—Any given point at the equator makes, naturally, during the daily rotation of the earth, a quicker movement towards east than one in higher latitudes or at the pole. Now, if a body moves gradually from the equator towards the pole, it will possess a larger velocity of rotation than the ground to which it advances, and will move quicker towards east than the objects which surround it. A river in the northern hemisphere, flowing towards north, thus arrives in latitudes which possess a smaller velocity of rotation than itself. Its banks will, as it were, remain behind in the rotating motion, and consequently its waters will push towards east, or against the right bank. If, on the other hand, a river in the northern hemisphere flows towards south, it is evident, when its waters arrive in latitudes with a higher velocity of rotation, that its banks will, as it were, advance ahead of the water, and consequently the latter will exercise a greater pressure towards west, or towards the right; so that again the right bank will be washed away. Of course this effect will be the more powerful and conspicuous the more the direction of the river coincides with the meridian. It is natural that in the southern hemisphere the direction will be reversed, so that all the rivers will push towards the left. According to von Baer all the large Russian rivers, as for instance the Volga, Ural, Ob, and Jenessei, and, as von Hochstetter states, the Danube between Vienna and Belgrade, show the correctness of the theory; and lately searching through the published accounts of travels in North America and Canada I find that similar observations have been made in those countries.

The application to our own rivers in New Zealand is also easily made, and shows that they conform to this law. Thus, for instance, the river traversing the Canterbury Plains, which flows nearest in a meridional line, is the Rangitata, and there, as previously observed, the difference between the right and left bank is most conspicuous, whilst all the other rivers without exception show in the same way a marked tendency to advance towards their left or northern banks. None of our rivers have been watched so continuously and anxiously as the Waimakariri, and although the tendency of its waters, principally during freshes, to wash its northern or left banks away, was well recognised, no *vera causa* for such direction could be assigned, except, as I had assumed in my report on the formation of the Canterbury Plains, that a small local rise of Banks Peninsula was probably taking place. However, as this tendency of the Waimakariri to advance with its waters towards the left is the outcome of a general law, and may be considered constant, the southern banks will every year become more

protected by the shingle which is shifted from the left or northern to the opposite side, and by which, as it were, natural dams are thrown up. Thus nature assists the work of man to confine the river in a properly defined channel.

There are very few other New Zealand rivers which for long distances have banks built up of soft incoherent materials, but where they exist they invariably conform to this law; their left banks being always the highest and most conspicuous, with a tendency of their waters to undermine these left banks in whatever direction they may happen to flow. Of the large Australian rivers, I know only the Murray, at Echuca (Victoria), and also there the rule holds good, the left or southern bank being the highest and best defined.

I shall now proceed to offer you a description of the remarkable rock paintings found on a rock-shelter in the Weka Pass ranges. Of the latter, the spirited water-colour sketch of Mr. T. S. Cousins is a faithful representation. I also have much pleasure in exhibiting to you the original copies of the paintings made by Mr. Cousins on a scale of from six inches to one inch to the foot, according to their size, as well as a general view of the whole on the uniform scale of one inch to the foot. About a year ago, Mr. Alexander Lean informed me of the existence of these paintings, which are situated on an educational reserve about one mile on the western side of the Weka Pass road, not far from the last rise from which that picturesque road descends into the Waikari Flat. Shortly afterwards, in company with Mr. H. M'Ilraith, I visited them, and I need scarcely observe that I was very much struck with their peculiar character and their state of partial preservation, from which their great age could be inferred. The so-called cave, which is, however, only a rock-shelter, is washed out of a vertical wall of rock, lining a small valley for about 800 feet on its right or southern side. It has a length of 65 feet, and is situated along the western or upper portion of the rock. The valley itself is now perfectly dry, but must, in post-pliocene times, have had a not inconsiderable volume of water flowing through it. The rock consists of the well-known calcareous Weka Pass sandstone, and the roof of the shelter is formed by the natural dip of the upper bed, having an inclination of about nine degrees to the south. The rock-shelter is, when standing, near the foot of the rock below it, which latter has, for about five to six feet, a backward slope about eight feet high, rising to about twelve feet at the outer edge.

The average depth is twelve feet, and, offering from its aspect a splendid shelter from southerly weather, it forms a most favourable locality for camping. The two sections which I have the honour to submit to you will make you acquainted with the physical features of the locality. The

whole length of the rock below the shelter has been used for painting, and it is evident that some order has been followed in the arrangement of the subjects and figures. The paintings are done with a bold hand; they are well finished, and show clearly that they are the work of an artist of times long gone by, who was no novice in his profession. The paint consists of kokowai (red oxide of iron), of which the present aborigines of New Zealand make still extensive use, and of some fatty substance, such as fish-oil, or perhaps some oily bird-fat. It has been well fixed upon the somewhat porous rock, and no amount of rubbing will bring it off. It is evident, however, that the existing paintings, which are already partly destroyed by the scaling off of the rock through the influence of frost and other physical agencies causing weathering, are not the first which were delineated on this rock, because in many spots, and sometimes below the paintings under consideration, faint traces of still older ones are visible. These were also painted in red, but I was not able to distinguish any outlines.

Thus we have here another proof, if it were needed, of the vast period of time during which New Zealand has been inhabited by man.

As before observed, the principal paintings are all in red, belonging all to one period, but round and above them appears a mass of others in black, of which some of the best and clearest have also been copied by Mr. Cousins. They are of a more primitive nature, and seem to have been done by a different race of men. That they are not contemporaneous with the red ones could easily be ascertained, by observing that they pass not only indiscriminately over them, but that many of them were only painted after the rock had already scaled off under the red ones, so that they are sometimes painted upon the newly exposed fresh surface. They are all most probably painted with charcoal mixed with some oily animal substance, and are also well fixed upon the rock, but they are generally not so well defined, and, moreover, cross each other constantly, so that it is very difficult to distinguish many of them clearly.

Mr. Cousins has, therefore, only copied a few of the figures which were the most conspicuous and well defined, mostly situate near and on the roof of the rock-shelter.

Before giving a description of these paintings, I wish to refer to the native traditions about them, as this will give us perhaps a clue to their origin. It has generally been supposed that such paintings were the work of the Ngatimamoe;* but the Rev. James W. Stack informs me that even a greater age is assigned to them. From a conversation which that gentleman had with Matiaha Tira Morehu, the Maori chief of Moeraki,

* See "Trans. N.Z. Inst.," I., 18, 2 ed., 5, where several paintings, but of a somewhat different character, are figured.

and the best living authority on Maori traditions in the South Island, it appears that these paintings are attributed to the Ngapuhi, the oldest inhabitants of this island of which there are any traditions. In fact, the Ngapuhi are a somewhat mythical people, to whom, besides these drawings, the destruction of the moa, or anything the origin of which is unknown, is always attributed. I may here observe that Matiaha is one of the authorities for the statement that the moa has been extinct in very ancient times, and that there is a total absence of reliable traditions about them amongst the Maoris, which tallies perfectly with the geological evidence lately brought forward. Besides the extinction of the moa and the red paintings, Matiaha also attributes to them the heaps of pipi shells *(Mesodesma novæ-zealandiæ)* which are found far back in the mountain ranges, and which were carried to such a distance by this people, who, according to the aged Maori chief, were great travellers. I have much pleasure in adding, in Appendix No. 1, a fuller account of their ancient traditions from the pen of Mr. Stack.

In my papers on the Sumner Cave* I have alluded to that question more fully.

It has been ascertained that there are several caves and rock-shelters in this island in which paintings of similar character are preserved on the walls, of which, as before observed, those of the Takiroa rock-shelter near the Waitaki were published in our "Transactions,"† but none of the paintings are like those from the Weka Pass, except, perhaps, the sparks rising from the figure in the right-hand corner. Moreover, one of the drawings is a scroll work and thus approaches the designs of the Maoris of the past few centuries. There are others at the Opihi, at the Levels, Tengawai, and at Pareora, and, as I have just been informed, in some other places in the Weka Pass Ranges, and doubtless in many other localities. It would be of the highest interest to have these carefully copied, as, no doubt, they will throw considerable light upon the history of the ancient inhabitants of this island.

My friend, the Rev. James W. Stack, has given me a copy of a drawing from a rock-shelter near the Opihi River, painted in black, which differs considerably from the Weka Pass paintings, and, as it appears to me, approaches more the designs of the Maoris. I add the same (fig. 3) with Mr. Stack's note as Appendix 2.

In examining the paintings under review, it is evident, at a first glance, that they are quite distinct from those of the Maoris, which always consist of curved lines and scroll-work, although in former days the traveller

* "Trans. N.Z. Inst.," VII., Art. 2.

† Mantell, "Trans. N.Z. Inst.," I., 18, 2 ed., 5.

would occasionally see on posts or smooth rocks, rude representations of men, ships, canoes, and animals drawn by Maori children, but they were always of an ephemeral character—Maori artists confining themselves to the drawing of scrolls, and then always in permanent colours. In looking at the *ensemble* of these rock-paintings, it is clear that there is some method in the arrangement which at once strikes the eye as remarkable. Some of the principal objects evidently belong to the animal kingdom, and represent animals which either do not occur in New Zealand, or are only of a mythical and fabulous character. Some of them can easily be recognised; the meaning of others can only be conjectured. The group in the centre is of a different character, which is difficult to explain, unless we assume that it represents implements and portions of dress of a semi-civilised people. Only two representations of man can be recognised, but they are full of movement and evidently in the act of running away, whilst the figure of the bird is very suggestive. Below these principal groups we find several smaller figures or signs, the meaning of which for a long time considerably puzzled me. I was inclined to believe that they might be a kind of hieroglyphic writing, but unfortunately there were too few of them we thought worth copying, the greater portion having much faded or broken away. Some of those which were too faint occurred at nine, thirty, and forty-six feet from the left-hand side. They were sometimes close to the floor of the rock-shelter, but did not go below it, which is of some importance to prove that the kitchen middens which had here accumulated were either forming, or had already been formed, when the paintings were executed. The thought struck me at last that these smaller figures resembled the letters of some oriental languages, and that I had seen somewhat similar characters published in our "Transactions." The Tamil inscription round the antique bronze bell, now in the possession of the Rev. W. Colenso, in Napier, at once suggested itself to me; and in comparing the peculiar figures with the writing on that bell, as given in Mr. J. T. Thomson's interesting paper,* I was at once struck by the marked resemblance between both. It would be a most curious coincidence and difficult to imagine, that the ancient inhabitants of this island should adopt similar figures, and place them, as it were, below the representations of animals, some of foreign countries, or scenes of life without any meaning; or should we assume that, as the bell with the Tamil inscription was found in New Zealand, so other objects were secured from the same or another similar wreck, amongst which pictures of animals and adventures of human life, with writing below them, were obtained, and which afterwards were copied

* "Ethnographical Considerations on the Whence of the Maori," by J. T. Thomson, F.R.G.S., "Trans. N.Z. Inst.," IV., 23.

after a fashion by the autochthones of New Zealand? Or might I even suggest that one or more of the wrecked mariners of Indian origin were saved, and that they accompanied as slaves the ancient inhabitants of this island on their journeys, during which these paintings were executed by them?

These ancient works of primitive art, as of considerable historic value, are therefore invested with still greater interest, and I have no doubt that further research will make us acquainted with more of these remarkable relics of the past. I may here observe that as far back as 1862 I met with paintings of similar character and in a splendid state of preservation, during my geological surveys in the south, but which I then passed over, imagining that they were probably the work of some shepherd who had devoted his leisure hours to the execution of these strange figures and characters with the red paint with which sheep are usually branded. I was then, to speak in colonial language, comparatively a new chum, but I may console myself with the fact that many of our intelligent settlers have looked at them quite in the same light. However, I shall not fail to collect all the material as soon as I can find the time, and hope that the settlers in limestone country will kindly inform me where such paintings are still existing. As before observed, the paintings under review occur over a face of about sixty-five feet, and the upper end of some reaches eight feet above the floor; the average height, however, being four to five feet. They are all of considerable size, most of them measuring several feet, and even one of them having a length of fifteen feet.

Beginning at the eastern end, we find in the left-hand corner the representation (No. 1) of what might be taken for a sperm whale, with its mouth wide open, diving downwards. This figure is three feet long. Five feet from it is another figure (No. 3), which might also represent a whale or some fabulous two-headed marine monster. This painting is three feet four inches long. Below it, a little to the left, in No. 4, we have the representation of a large snake possessing a swollen head and a long protruding tongue. This figure is nearly three feet long, and shows numerous windings. It is difficult to conceive how the natives, in a country without snakes, could not only have traditions about them, but actually be able to picture them, without they had received amongst them immigrants from tropical countries who had landed on the coasts of New Zealand from some cause or another. You are well aware that already on the second visit of Captain Cook, Tawaihura, a native chief of Queen Charlotte Sound, gave an account of enormous snakes and lizards to him, and drew a representation of both animals so distinctly that they could not be mistaken, but hitherto the researches of naturalists for so many years have

failed to reveal their existence in these islands. Between the two fishes, or whales, we have No. 2, which might represent a fishhook, and below the snake, No. 5, a sword with a curved blade, whilst No. 6, in the same line is one of those remarkable signs or letters. Advancing towards the right, we reach a group which is of special interest to us, the figure, No. 9, which is nearly a foot long, having all the appearance of a long-necked bird, carrying the head as the cassowary and emu do, and as the moa has done. If this figure does not represent a moa, it might be a reminiscence by tradition of the cassowary. The figure is, unfortunately, not complete, as only the portion of one leg has been preserved. The forked tail is, however, unnatural, and if this design should represent the moa, I might suggest that it was either a conventional way of drawing that bird, or that it was already extinct when this representation was painted according to tradition; in which latter case No. 11 might represent the taniwha, or gigantic fabulous lizard which is said to have watched the moa. No. 8 is doubtless a quadruped, probably a dog, which, as my researches have shown, was a contemporary of the moa, and was used also as food by the moa-hunters. No. 10 is evidently a weapon, probably an adze or tomahawk, and might, being close to the supposed bird, indicate the manner in which the latter was killed during the chase. The post with the two branches near the top (No. 12) finds a counterpart in the remnant of a similar figure, not numbered, between the figures Nos. 8 and 9. They might represent some of the means by which the moa was caught, or indicate that it existed in open country between the forest. No. 13, under which the rock in the central portion has scaled off, is, like No. 6, one of the designs which resembles ancient oriental writing. Approaching the middle portion of the wall, we find here a well-arranged group of paintings, the centre of which has all the appearance of a hat ornamented on the crown. The rim of this broad-brimmed relic measures two feet across. The expert of ancient customs and habits of the Malayan and South Indian countries might perhaps be able to throw some light upon this and the surrounding figures, Nos. 15 and 18, to which I can offer no palpable suggestion. From No. 17, which is altogether three feet high, evidently issues fire or smoke; it therefore might represent a tree on fire, a lamp, or an altar with incense offering. If we compare this peculiar appearance with one of the figures on the copy of the Takiroa Cave paintings, we find that it has the same characteristic feature. The figure No. 15 is particularly well painted, and the outlines are clearly defined, but I can make no suggestion as to its meaning. In No. 19 we have doubtless the picture of a human being, who is running away from No. 17, the object from the top of which issues fire or smoke, and I need scarcely point out to you that this small figure is full

of life, and that it is entirely different from the conventional representation of the human figure in the paintings and carvings of the Maoris.

I am strengthened in my conviction that it is meant for a man, by observing a similar figure running away from the monster No. 27. No. 16, which has been placed below that group, might be compared to a pair of spectacles, but is probably a letter, or an imitation of such a sign. A little more to the right a figure six feet long is very prominent. It is probably the representation of a right whale in the act of spouting. Above it, in No. 22, the figure of a *Mantis* is easily recognisable; whilst Nos. 21 and 21A, below the supposed right whale, are again cyphers or letters resembling those of the ancient Tamil inscription. Nos. 23 and 25, although in many respects different, belong, doubtless, to the same group, and represent large lizards or crocodiles. Between them the now empty space of a width of 5 feet 6 inches was evidently also painted over, of which the faint marks on the partially scaled off face of the rock can be distinguished. The left-hand figure is four feet long; it is, unfortunately, deficient in its lower portion, but it is still sufficiently preserved to show that besides four legs it possesses two other lower appendages, of which one is forked and the other has the appearance of a trident. I wish also to draw attention to the unusual form of the head. No. 25 is a similar animal three feet long, but it has eight legs, and head and tail are well defined. The head is well rounded off, and both animals represent, without doubt, some fabulous animal, such as the taniwha, which is generally described as a huge crocodile, of which the ancient legends give so many accounts.

No. 27, a huge snake-like animal fifteen feet long, is probably a representation of the Tuna tuoro—a mythical monster, and of which Mr. Stack gives such an interesting account in his notes, kindly furnished to me, and which I have added as Appendix No. 3. It is evident that the Tuna tuoro is in the act of swallowing a man, No. 29, who tries to save himself by running away from it. Now, if we admit that the characters below the figures denote an Indian origin, the deduction would not be too hazardous that the accounts of huge snakes and crocodiles were brought by the writers of these signs to New Zealand, or if only pictures or books were obtained from a wreck, the ancient inhabitants of these islands founded their legends of such monsters upon them. Thus 23 and 25 might be crocodiles, No. 27 a boa-constrictor. The figure 26 above the large monster may represent, like 8, a quadruped, probably a dog; and finally, No. 28 is a good picture of a seal or dogfish. The paintings in black are altogether of another style, and have been done in a far more recent period when the aborigines were less skilled. But although these designs are all very juvenile, if we except, perhaps, the animals, which can easily be recognised, they have been

painted at various times, because in many places the rock-surface below them has scaled off, and new ones pass over the thus exposed face. The whole interior of the rock-shelter being covered with these paintings, passing first indiscriminately over the red ones as well as over each other, it was found impossible to make copies of the greatest portion of them. Moreover, they nearly all represent the human form, and we selected a few of the most characteristic ones, which will be sufficient to show their peculiar features.

In the left-hand corner, close to a large shark-like animal, which, however, was too much effaced to be properly copied, were two groups of animals in a sitting position, probably dogs, of which I had the best-preserved one copied. They evidently are tearing something eatable between them. In the centre of the wall is a figure which might be taken for a *Mantis*, whilst close to it the figure of a seal is unmistakeable. The rest, with the exception of a three-pronged (eel ?) fork, represent the human figure, of which one has a stick in his hand. When the hands and feet are represented, the former have generally four fingers and the latter five toes. One of these figures has two calabashes hanging from its thigh. It is most remarkable that none of these paintings are indecent, which is so characteristic of all Maori carvings and paintings of the human figure. These black paintings, although of such rude conception, are without doubt the work of full-grown men, as many of them are eight feet above the floor of the cave.

The surface of the floor under this rock-shelter showed on both sides a gentle undulation separated towards the centre by about ten feet of lower ground, and which, as I had occasion to observe, stands under water during heavy rains, quite a streamlet running in from the higher ground to the west. At first sight the nature of the ground indicated that it had doubtless been accumulating during human occupancy. However, as I had not the time to stay in order to have the necessary excavations made under my eyes, I sent towards the end of February one of the museum staff, Mr. W. Sparks, junr., to do this. To test the ground, a trench was first dug from the centre of the cave, beginning at the wall and continuing the same for about thirty feet, and at right angles with it. Afterwards four more trenches were excavated on both sides of the first, running out for about sixteen feet from the interior. This done, the ground between these trenches and along the face of the wall was thoroughly searched. These excavations proved that kitchen middens of three distinct epochs existed below the rock-shelter, having their greatest depth of 1ft. 2in. close to the wall, and gradually thinning out, so that ten feet from the wall they had entirely disappeared, and the bed No. 8 of the annexed sections (fig. 2,) consisting

of vegetable mould mixed with small, mostly angular pieces of rock, overlapped them and took their place. This latter deposit is about one foot thick. Below both the kitchen middens and the somewhat contemporaneous deposit outside the cave, lies a layer of decomposed rock, a gritty bed enclosing a number of angular pieces of rock, the whole derived from the calcareous sandstone by which the valley is bounded. In this deposit the excavations were carried on to a depth of two feet, but without showing the least sign that it had either been disturbed or that traces of animal or human life had been entombed in it during its formation. The principal deposits accumulated under the rock-shelter may, *faute de mieux*, best be described as a dirt-bed, which doubtless owes its formation to the occasional presence of an autochthone race in the locality, and whose scanty kitchen middens give us a glance into the wandering life of its members. However, what appeared to me astonishing was the scarcity of the remnants of their food, the whole thickness of the bed (more than a foot) consisting of ashes and refuse, too minute to be recognised. The largest bed on the eastern side was about twenty-five feet long by ten feet broad; amongst it only a few objects were found. Amongst these some few pieces of moa bones were the most interesting, but they showed convincingly that they were portions of remnants of a meal, all the leg bones having been broken for the extraction of the marrow, and resembling in every respect the fragments collected in the Moa Bone Point Cave, and at the Rakaia Encampment. These fragments, as far as I could recognise them, belonged to the two *Meionornis* species, birds of small size, and some of the swiftest runners of the *Dinornithidæ*. Besides these bones, the presence of which proves occupation of the moa-hunters during their expeditions, and by which my suggestion that No. 9 may represent a moa gains in probability, there were a number of bones of smaller birds amongst the kitchen middens, of which those of the kiwi (*Apteryx oweni*) were the most prominent. Other remains belonging to the animal kingdom, and showing that the moa-hunters had come from the sea coast, were a few marine shells, mostly *Mesodesma novæ-zealandiæ*, the pipi of the Maoris. The presence of phalanges of a large fur seal, probably *Arctocephalus cinereus*, so far inland in such locality was rather surprising, unless we assume that they perhaps were used for playing some game. Besides these there were a few small pieces of wood, probably firesticks, some fragments of chert and flint, either cores or chips; several pieces of dark sandstone, of which one is a fragment of a polished stone implement. Another large piece of calcareous sandstone had evidently been chipped to a point. In the other somewhat smaller heaps on the western side, which have a length of about sixteen feet, with a greatest breadth of eight feet, also some few fragments of broken moa leg bones

were obtained, but too small for recognition of the species. There were also some phalanges of the fur seal, a number of bones of small birds, and several marine shells, some of them fragmentary, belonging to *Mesodesma novæ-zealandiæ*, *Mactra discors*, and *Mytilus smaragdinus*, the New Zealand mussel. Flakes of chert and flint were, as usual, present, as well as some fragments of a polished stone implement. There were also two large sub-angular boulders of sandstone, doubtless brought up from the river-bed of the Waikari.

Principally towards the centre of the rock-shelter, and where the older deposits were thinnest, occurred above them accumulations of Maori and European origin. Amongst them are, in the collection made, several pieces of *Haliotis iris*, the pawa shell of the Maoris, which had evidently been worked, but the presence of numerous pieces of Newcastle coal, of ribs and other portions of the sheep, and the iron tip of a man's boot, told clearly its tale. This bed, about six inches thick and about eight feet long and four feet wide, was resting on both sides on the older deposits with broken moa bones. It is in this spot where the water during heavy rain, as experienced by Mr. Cousins and myself, is flowing against the wall of the rock-shelter, and it therefore stands to reason that these remnants of European occupancy could easily be trampled into the ground, and thus reach a deeper position than they otherwise naturally would have possessed. No remains of red or black paint, or of a receptacle for the paint, were amongst the kitchen middens. These excavations revealed another important fact—namely, that the small drawings which were close to the floor of the rock-shelter, and often reached to it, but were too faint to be copied, never went below it. It perhaps would not be too rash to surmise that the people who formed the kitchen middens made the paintings, during their visits, lying on the ground, when the lower ones were executed; on the other hand, they could just reach the top of the shelter when they stood upright to finish the larger figures previously described. I must confess I was rather disappointed not to receive a larger quantity of objects from the kitchen middens, and of more interest. We must, therefore, conclude that the rock-shelter was only seldom visited by man, and then was only inhabited for a very short time.

I hope that, very soon, I shall have another opportunity to communicate to you the results of further researches on this very interesting subject. I trust that some of our members will also take their share in the elucidation of a question which may throw considerable light upon the pre-historic inhabitants of these fair islands, on which so many members of a race different from their present aborigines have found a happy home.

Since the above was written, I had the great advantage of consulting

the Rev. Robert Pargiter, who for many years has been living in Ceylon, and who is thoroughly conversant with the Tamil and some other oriental languages; and although that gentleman was not able to pronounce the figures in question to have the exact form of any *single* Tamil character, he thinks that there is some resemblance between No. 6 of Waikari rock paintings and the sixth character, T H E of the inscription upon the ancient Tamil bell, and of No. 21A, with the tenth letter, K U, of the same inscription, counting both from the left. Mr. Pargiter makes, however, another important suggestion, that the inscriptions, Nos. 6, 21, and 21A, may be the signatures of the artist, as, according to his experience, the Tamil natives have a peculiar way of combining two or more letters in one character, which is very difficult to decipher except by the writer himself and those best acquainted with him. Thus, for instance, in their signatures, the natives combine generally the initials of their names, and in this case, No. 21A, for instance, might be taken for M and S combined, being, in fact, a monogram.

Mr. Pargiter also informs me that No. 21 has some resemblance to one of the Cingalese characters, which are generally formed by the combination of circles.

Note.—During the discussion as to the probable ages of the rock paintings in the Weka Pass Ranges, I observed that the expression applied to them by me, as being of great antiquity, gave rise to misunderstandings. In using such expression I never dreamt to do so in the sense it is used in the northern hemisphere, but only in reference to the short space of time of which we have reliable traditional evidence in New Zealand.

Appendix No. 1.

Extract from a paper on the History of the South Island Natives.

By the Rev. James W. Stack.

Maori traditions trace the first occupation of this island back to Te Kahui Tipua (the monster herd or ogre band), a purely mythical race. They are described as giants, who could stride from mountain range to mountain range, swallow rivers, and transform themselves into anything animate or inanimate that they chose. They were succeeded by Te Rapuwai or Ngapuhi, who spread themselves over the greater part of the South Island, and who have left traces of their occupation in the shell-heaps both along the coast and far inland. It was in their time that the country around Invercargill is said to have been submerged, the forests of Canterbury and Otago destroyed by fire, and the moa exterminated. The traditions relating to these people are so vague and fragmentary that very little reliance can be placed upon them. It is with the Waitaha that the first reliable

history of the Maoris begins. This tribe sprang from a chief of that name, who came from Hawaiki in the canoe Arawa, commanded by Tama te Kapua. Their first home was on the shores of Lake Taupo, but they were soon driven away southwards by their more powerful neighbours, and eventually crossed the straits about 400 years ago. The Ngatimamoe supplanted the Waitaha, and were in their turn supplanted by Ngatikuri, the present inhabitants.

APPENDIX No. 2.

Description of an ancient Drawing on a Rock-shelter at Parihaka, near the Gorge of the Opihi, South Canterbury. By the Rev. J. W. STACK.

Although I had heard for many years from the Maoris of the existence of these drawings, which were popularly attributed to the Ngatimamoe, I was never able to examine them till November, 1875, when I went to see them, accompanied by my friend, Mr. C. M. Wakefield. Owing to the incompetency of our guide, we were not taken to the spot where the best specimens exist, but to a long shallow cave or "rock-shelter," on the north bank of the river Opihi. The cave is about 200 yards long, 10 feet wide, and 12 feet high, and protected from the weather by a dense growth of shrubs. The entire surface of the rock is covered with drawings, which, however, are unfortunately so defaced by modern scrawls, that it is impossible to distinguish their exact forms. For since the natives have lost their superstitious regard for these relics of antiquity, the celing parties who frequent the spot make a practice of scratching rude drawings with charcoal all over them. The only perfect specimen I could find was near the eastern end, and at a height of fourteen feet from the ground. It was about five feet long, and had evidently been very carefully drawn. The black paint used by the artist has stood exposure so well, that the lines, from the crumbling away of the rock between them, are now somewhat in relief.

There is a remarkable difference between this drawing and those found at Waikari, so great that I hardly think that they can belong to the same period. The parallel lines on the Parihaka drawings bear a strong resemblance to the patterns on Maori baskets and the battens of ornamented roofs. Although I could not distinguish the shapes drawn, I saw everywhere these parallel lines and curves, but nowhere anything like the Waikari drawings, which are either only outlines or coloured throughout. This fact confirms, in my opinion, the statement made by Matiaha Tira Morehu respecting the far greater antiquity of the Waikari drawings. I showed the copy I made of the Parihaka drawing to the Rev. Koti Rato, Wesleyan Minister at Rapaki, and to Hone Paratene, late M.H.R., and other intelligent natives, who concurred in the opinion that it was the representation of

a Tipua, or fabulous marine monster. My own conjecture was that it was meant to represent a seal. (Fig. 8.)

March 27, 1877.

Appendix No. 3.

Note on the Tuna Tuoro. By the Rev. James W. Stack.

The descriptions given of this eel vary so very much, that it would be hard to believe that anything of the kind ever existed if it were not for the general concurrence of native testimony both in the North and South Islands to its existence.

It seems to have combined some of the characteristics of the frog, the electric eel, and the watersnake. It uttered croaking sounds, rendered senseless anyone it touched, and pursued its prey with such rapidity that it was next to impossible to escape from it.

In 1853 I was told by Hoani Huki, a Waikato chief, and a catechist in the employ of the Church Mission, that when he was a lad (that was about thirty years before) he distinctly heard the tuna tuoro in the swamps in the Upper Waikato, that at that time the older men often described their encounters with it, and that they greatly dreaded it, for when wading about eeling in the shallow waters, which it frequented, there was a danger of its gliding up imperceptibly and touching them, and anyone so touched was instantly paralyzed and destroyed. It would even pursue its prey on to the dry ground, and its progress could only be checked by setting fire to the grass or fern, when the ash adhering to its slimy body rendered it helpless and incapable of moving any further.

Here in the South Island I have frequently heard of the existence of the tuoro within recent times. Tainui and Pita Mutu informed me that they once found on the beach near Greymouth, where they resided, what they believed to be a portion of the body of a tuoro; it was after a heavy fresh in the river, and they supposed it had been carried down from some of the lakes in the interior. The skin they described as scaly, employing a flax plait of four to convey an idea of its appearance. Paora Taki, Native Assessor at Rapaki, also informed me that it was commonly reported fifty years ago that one existed near the source of the Purau stream in Lyttelton harbour.

Though I believe that there must be some foundation for reports so common and so general regarding the recent existence of this strange creature, I am not prepared at present to put forward any theory about it, except that I think that it is highly probable that the Maoris have mixed up the descriptions of two or three different things which existed a short time back but are now extinct.

ART. V.—*Sketch of the Traditional History of the South Island Maoris.*
By the Rev. JAMES W. STACK.
Plate II.

[*Read before the Philosophical Institute of Canterbury, 6th September and 4th October,* 1877.]

TABLE OF CONTENTS.

As the value of this paper must depend entirely upon the trustworthiness of its contents, it is important that I should state at the outset the sources from whence my information was derived.

Sources of Information.

In the first place, then, I am indebted to the late Peta Te Hone, of Kaiapoi, for most of these traditions. That chief was universally acknowledged by the Ngai Tahu to be a high authority on all questions relating to their past history. Since 1863, I have repeatedly submitted my notes to chiefs in all parts of this island, and have carefully recorded their comments, and this paper contains the result of my inquiries.

Amongst others whom I have consulted I may name Hapakuku Kairua, Hakopa te Ata o Tu, and Wiremu te Uki, of Kaiapoi; the late chief Whakatau, of Kaikoura; Tamati Tikao, and Apera Pukenui, of Banks Peninsula; Te Mararoa, and Tarawhata, of Arowhenua; Matiaha Tira Morehu, and Natanawhira Waruwarutu, of Moeraki; Tarekahu, of Otago Heads; Pukuheti and Hutoitoi, and Rawiri, of Riverton; and Wereta Tainui, of Greymouth; besides very many others.

Classification of Traditions.

The traditions may be divided into three classes—the mythical, the uncertain, and the reliable. The mythical relate to pre-historic times, and

to supernatural beings; the uncertain relate to those tribes which have perished, and whose only memorial is contained in the fragmentary notices which occur in the story of those who superseded and survive them; the reliable comprise the history of Ngai Tahu during the last 200 years.

But as the reliability of any oral tradition may fairly be questioned, I will endeavour to show why these may be considered worthy of credit, and also how, in the absence of a written language, the Maoris were enabled accurately to preserve their history. Every tribe was composed of hapus, and every hapu of families. Each family, hapu, and iwi carefully preserved the names of their ancestors, and their ancestors' wives and offspring. In transmitting this knowledge, the greatest care was taken to avoid errors, because, as the Maoris were very punctilious in the matter of precedence, a mistake made on the occasion of any public assembly of the tribes might be construed into an insult, and result in a blood feud. Such mistakes were all the more likely to happen from the custom which prevailed, when speaking of a chief, of alluding to him as a relation—"Brother, uncle, son, grandson, nephew, brother-in-law," etc., etc. A very accurate knowledge of tribal genealogies was therefore required to enable a speaker to apply to any given person that term which exactly described the rank to which he was entitled in the tribe. This knowledge was not confined to a class of learned genealogists, but was possessed by every rangatira or native gentleman. To acquire it, each one from childhood up was obliged to make this subject a constant study; and the public recitals which were held at frequent intervals kept the names and the facts connected with them always fresh in their memories; for, besides the names of their ancestors it was held to be of equal importance to know the deeds for which they were distinguished. The value attached by the Maoris to land is too well known. From the time that the first arrivals from Hawaiki ascended the highest mountains to partition all the country they could see from thence amongst themselves, the title to land has been a fruitful source of strife. Every part of the country was owned and named. Not only were the large mountains, rivers, and plains named, but every hillock, streamlet, and valley. These names frequently contained allusions to persons or events, and thus served to perpetuate the memory of them and to preserve the history of the past. Every Maori was required to know by what title the land claimed by his tribe was held, whether by right of original occupation, conquest, purchase, or gift; and thus it happened that traditions relating to the same transactions were preserved by tribes whose interests were antagonistic; and several opportunities have been afforded in recent times of comparing these accounts, which have been transmitted for several generations through separate and independent channels, and they have

invariably been found to agree. With this fact before us, it is hardly possible to deny the historical value of a large portion of these traditions, which have been preserved by the same method but which cannot be vouched for in the same manner.

Difficulty of unravelling the Thread of the History.

I experienced considerably difficulty at first in disentangling the complicated narratives, because my Maori informants being themselves so familiar with the history did not see the necessity of explaining as they went along why things happened as they did. They would repeatedly break off from the continuous history of the tribe to follow the fortunes of a favourite hero, and again as abruptly leave him to resume the thread of the original narrative. One prolific source of confusion arose from the intermarriages which took place between the members of hostile tribes. It was bewildering to find the same person fighting for one tribe but wishing success to the other, and guilty of treachery towards both. The man who married a Ngatimamoe woman would be found plotting the ruin of his wife's relations; and the Nagitmamoe man who, by marriage with a Ngai Tahu woman, was admitted to that tribe, would still sympathize with his own people, and betray his connections whenever he could. Another element of confusion arose from the two tribes being spoken of as totally distinct from each other, whereas they had a common origin, and this fact afforded the only explanation of many strange things done on either side. The history throughout is one dark narrative of treachery and ferocity, brightened here and there by displays of great courage and occasional acts of generosity.

Chronology.

The method I have adopted for ascertaining the chronological order in which the various events occurred, has been first to form a genealogical table, and then allowing *twenty years for a generation, to count back the generations from the present time, and thus fix the date of any event by the position in the table which the persons connected with it occupy. For instance, to ascertain the date of the death of Manawa, take Hakopa te Ata o Tu, now living, and who is at least seventy years of age, counting back from his birth to Manawa's there are eight generations, equivalent to 160 years, which added to 70 gives a total of 210. Manawa, therefore, was born about 1667; and, as he had a grown-up son, he was probably not less than forty years old when he was killed. His death, then, occurred about 1707. Of course this plan only gives an approximate date, but it

*I have fixed on twenty years, as the Maoris married early.

is sufficiently near to render the history intelligible, though further investigation may lead to some alteration being made here and there in the sequence of events.

The history may be divided into four periods:—

1st. Prior to the arrival of Waitaha.
2nd. Waitaha occupation, 1477 to 1577.
3rd. Ngatimamoe occupation, 1577 to 1677.
4th. Ngai Tahu occupation, 1677 to 1827 (the date of Rauparaha's invasion).

Fabulous Traditions.

The Kahui Tipua or ogre band, a mythical race, are said to have been the first occupants of this island. They are described as giants, who could stride from mountain range to mountain range, swallow rivers, and transform themselves into anything animate or inanimate that they chose. The legend of the ogre of Matau (Molyneux) may be taken as a specimen of this class of tradition.

When Te Rapuwai who dwelt at Matau went in small parties of ten to hunt for wekas they never returned. Tens and tens went out and never came back. Then every one felt sure something was consuming them, but what it was they could not tell. A long time passed, and then it was found out how these people perished. It was learnt from a woman—the sole survivor of one of these hunting parties. She said that on the hills they were met by an ogre, accompanied by ten two-headed dogs. After killing all the men he carried her to his cave near the river, where she lived with him, and in time became covered all over with scales from the ogre's body. She was very miserable and determined to escape; but this was not easy, as the ogre took care to fasten her by a cord, which he kept jerking whenever she was out of his sight. As the cave was close to the river, she crept to the entrance where raupo grew thickly, and, having cut a quantity, tied it in bundles. The next day when the monster slept, she crept out and formed the raupo bundles into a raft, then tying the string to the rushes, which, being elastic, would prevent the immediate discovery of her flight when the cord was jerked. Getting on to the raft, she dropped down the river, the swift current bearing her rapidly towards its mouth where her friends lived.

The ogre did not wake for a long time, when he did he called out, "Kai a mio, E! where are you?" Not receiving an answer, he went to the entrance of the cave and searched; not finding any footprints there he smelt the water, and at once discovered how she had escaped. Then in his rage he swallowed the river and dried it up from end to end, but not before Kai a mio was safely housed in her native village. After cleaning herself from the scales which covered her body, the woman told her people all she

knew about the ogre, and they resolved to put him to death. "When does he sleep?" they asked. "When the north-west wind blows" was her reply, "then he sleeps long and heavily." So they waited for a nor'-wester and then proceeded to the cave. Having collected a great quantity of fern which they piled at the entrance, they fired it. When the heat awoke the monster, he could think of no way of escape, except through a hole in the roof; while struggling to get out through this, the people set upon him with clubs and beat him to death. Fortunately the ogre's dogs were away hunting, or else he never could have been killed.

It was during this period that the canoe called Arai te uru was capsized off Moeraki and the cargo strewn along the beach, where may still be seen the eel-basket of Hape ki tauraki, and the slave Puketapu, and the calabashes and kumeras.

Passing on from these legends, we come to the traditions which I have classed as unreliable, relating as they do to tribes that have been utterly destroyed.

Uncertain Traditions.

Te Rapuwai or Nga ai tanga a te Puhirere succeeded the Kahui Tipua and rapidly spread themselves over the greater part of the island. They have left traces of their occupation in the shell-heaps found both along the coast and far inland. It was in their time that the country around Invercargill is said to have been submerged, the forests of Canterbury and Otago destroyed by fire, and the moa exterminated. I am inclined to think it is not at all improbable that Te Rapuwai and Waitaha were portions of the same tribe, Te Rapuwai forming the vanguard when the migration from the North Island took place. Several of my Maori authorities incline to this opinion, others maintain that they were separate tribes; if so they were probably cotemporaries, and like Rangitane and Ngai Tahu in subsequent times—one may have come from the west, and the other from the east coast of the other island.

Waitaha.

Of the Waitaha very little is known, their traditions having almost entirely perished with the extinction of their conquerors. But there is sufficient evidence to warrant the supposition that the few traditions which still remain were preserved by the remnant of Waitaha; who were spared by Ngatimamoe to work their fisheries and kumera plantations till they thought it necessary for their own safety to exterminate them in order to prevent their alliance with the invading Ngai Tahu. There is no reason therefore to regard the traditions relating to the Waitaha as mere fables.

It would appear that Waitaha—one of the original immigrants from Hawaiki—was the founder of the tribe. He came with Tama to Kapua and

Nga toro i rangi in the canoe Arawa, and his taumata near Taupo is still pointed out. But at a very early date he or his immediate descendants must have left that locality, and travelled south. Separated by the stormy straits of Raukawa from their countrymen, Waitaha were long left in the enjoyment of peace and plenty, and as a consequence rapidly increased, till as the natives say "they covered the land like ants." The size of the pas, and the extent of the kitchen middens along the coast attributed to them, afford conclusive evidence as to their numbers. At Mairangi and Kapukariki (Cust) the remains of a walled pa extending for about three miles along the downs, existed till the settlement of Europeans in that locality. Wiremu te Uki, Henare Pereita and others, who frequented the place to gather the stems of the cabbage-palm,—which grew luxuriantly there in "soil enriched by the fat of man"—for making kauru, a favourite article of food—assert that twenty years ago, the broad outer ditch of the pa could be seen, and that from the bottom of it to the top of the bank was about seven feet, and that at regular intervals along the wall there were openings showing plainly where the gates had been. They recollected old men saying that these gates were known to have had names which were now forgotten. Te Wai manongia and his son Tauhanga ahu are said to have ruled these pas at the time that they were destroyed by Ngatimamoe.

Some time before the Ngatimamoe invasion, about the year 1550 as near as we can guess, there lived on the banks of the Rakaia a chief named Tutewaimate, regarding whom a story worth recording has reached us. Moko, a robber chieftain, had fixed his stronghold on the Waipara, the choice of the spot being determined by the existence of a cave in close proximity to the highway, along which a regular trade was carried on up and down the coast; the preserved mutton-birds, dried fish, and kauru from the south being exchanged for preserved forest-birds, mats, etc., from the north. Moko was in the habit of robbing and murdering any small parties of carriers who might venture too near to him, and he might have continued to do so without molestation, as the carriers were for the most part slaves, whose death was not worth avenging, had he not been so unfortunate as to kill a near relation of the great Tutewaimate. This chief, already smarting under previous losses of property, was exasperated beyond all endurance by the murder of his kinsman, and summoned his tribe to destroy Moko and his band. The people responded in such numbers to his call, that when they started on their march, the dust they raised resembled the smoke of a great fire on the plains, and their spears darkened the sky. Leaving the bulk of his forces at Kapukariki, Tutewaimate pushed on early one morning with a few chosen warriors to Moko's stronghold. He found the place quite unprepared for an attack, all the men except Moko being away.

Having ascertained from some women whom he questioned that the robber chieftain was asleep in a cave hard by, he quietly approached the spot, where he found him lying asleep on a mat, all unconscious of danger. But like a true knight he scorned to strike his sleeping foe, and raising his voice he uttered the following challenge:

"Tutewaimate	"I, Tutewaimate
Tutewaimate a Popotahi	Tutewaimate, son of Popotahi,
Te hau tuku mai i roto Rakaia	Swift as the wind from the Rakaia Gorge
Te mahea te hauku o te ata."	Have forestalled the drying of the morning dew."

The startled robber, raising himself to a sitting posture, replied:

"Ho, Moko	"Ho Moko,
Moko a Hautere	Moko, son of Hautere,
Te hau tuku mai runga maunga tere	The wind rushing down from Mt. Tere,
Te tangata i whangai nga ki te mango mata."	The man fed upon uncooked shark."

As he uttered the last word the treacherous Moko, by a sudden and unexpected thrust, felled his generous foe to the ground, and soon put an end to his existence.

It is from the Waitaha that the following account of the destruction of a gigantic bird of prey has been handed down. The event occurred in times preceding Tutewaimate and the period referred to in the scraps of Waitaha history which have survived. The story possesses peculiar interest when considered in connection with the discovery of the *Harpagornis moorei* at Glenmark. Does it prove that the Maoris knew that bird, or is it to be classed with the Taniwha stories common in the north, is it an imported, and localized tradition?

A Pouakai had built its nest on a spur of Mount Tawera, and darting down from thence it seized and carried off men, women, and children, as food for itself and its young. For, though its wings made a loud noise as it flew through the air, it rushed with such rapidity upon its prey that none could escape from its talons. At length a brave man called Te Hau o Tawera came on a visit to the neighbourhood, and finding that the people were being destroyed, and that they were so paralyzed with fear as to be incapable of adopting any means for their own protection, he volunteered to capture and kill this rapacious bird, provided they would do what he told them. This they willingly promised, and having procured a quantity of manuka saplings he went one night with fifty men to the foot of the hill, where there was a pool, sixty feet in diameter. This he completely

covered over with a network formed of saplings, and under this he placed the fifty men armed with spears and thrusting weapons, while he himself as soon as it was light, went out to lure the Pouakai from its nest. He did not go far before that destroyer spied him, and swooped down upon him. Hautere had now to run for his life, and just succeeded in reaching the shelter of the network when the bird pounced upon him, and in its violent efforts to reach its prey, forced its legs through the meshes, and becoming entangled, the fifty men plunged their spears into its body and after a desperate encounter succeeded in killing it.*

The Waitaha, after a peaceful occupation of what was then known as the "food-abounding island," were obliged to resign possession of it into the hands of Ngatimamoe, and were ultimately destroyed or absorbed by them.

Ngati ma moe A.D. 1577 to A.D. 1677.

The origin of the Ngatimamoe is nearly as obscure as that of their predecessors. Like them they came from the North Island, being probably driven down before a stronger tribe. Their pitiless treatment of Waitaha was afterwards repeated upon themselves by the stronger and more warlike Ngai Tahu. Their destruction of the Waitaha and their own subsequent destruction, accounts for the absence of all traditions relating to the visit of Abel Tasman in 1642. Just as the destruction of the tribes inhabiting the shores of the straits by Rauparaha in this century, explains why no account of Captain Cook's visit in 1769 has been preserved amongst the natives now residing in that neighbourhood.

From the natives at the extreme south of the island, I obtained a genealogical table which traces their origin to the offspring of Awatopa. The following legend states the cause of their leaving the other island :—

Awatopa and Rauru were brothers, sons of Ruarangi and Manu tai hapua. They both commenced to build houses for themselves at the same time. Rauru was the first to finish; and having performed the ceremonies of purification, he announced his intention of going off on a voyage. His elder brother begged him to wait till he had completed his house, but this he refused to do, and, overcome with rage at his refusal, he killed him. The tribe hearing of what had taken place, avenged Rauru by killing Awatopa. This led to the secession of three families, children of the elder brother, namely—the Puhi kai ariki, Puhi manawanawa, and Matuku herekoti, who came south. The rest of the tribe remained behind. Relationship is claimed by the descendants of Ngatimamoe with Waikato through a Puhi of

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* Wereta Tainui, of Greymouth, says that near Inangahua there is a place called the Pouakai's Nest, and where tradition tells of one being killed. Irai Tihau of Wairewa saw at Poupoutunoa in Otago, in 1848, near the river Kaeaea, what was said to be a Pouakai's nest. The name may be translated the "old glutton."

the Awatopa clan who settled there, and to Ngapuhi hrough Muru nui, who was connected with Maru kore, one of their ancestors.

During the Ngatimamoe occupation, an event occurred which seems to throw some light upon the origin of the Chatham Islanders:—

Tradition says that a canoe, manned entirely by chiefs whose names are forgotten, but who are known now as "Nga toko ono," or The Six, went out from Parakakariki to fish, and when a long way off from the shore a violent nor'west wind sprung up and drove them out to sea, and they were never heard of again. It is not at all improbable that this canoe reached the Chathams, and that the crew became the progenitors of one section of the present inhabitants. Te Koti, a Maori Wesleyan minister who was stationed for some years on the principal island, states that the Morioris have preserved the names of many of the headlands around Akaroa, and that they number Mamoa (probably a corruption of Mamoe) amongst their ancestors. It is an interesting fact that many of the words in use by the Morioris are nearer akin to the Rarotongan form than the Maori equivalent.

It is quite clear that the Ngatimamoe, like the Ngai Tahu, came from the east coast of the North Island. How long it was before their possession of this island was disputed it is hard to guess correctly; but judging from their numbers, and the total subjugation of Waitaha to their rule when the Ngai Tahu appear on the scene, they could not have held it for less than 100 years.

A small tribe called Ngaitara were the first to make alliances with Ngatimamoe, and were the cause of Ngai Tahu crossing the straits.

Reliable Traditions.

NGAI TAHU.—*Causes that led to their Migration.*

About the year 1650 we find the Ngai Tahu located at Hataitai, between what is now called Wellington Harbour and the coast. In this pa dwelt a band of warriors renowned for courage and daring, whose warlike propensities had made them rather obnoxious to their kinsmen and neighbours, the Ngatikahununu. Among this band dwelt an old chief named Kahukura te paku, who was connected with the Ngaitara tribe, then settled at Waimea, in the South Island. His son, Tu maro, was married to Rakai te kura, daughter of Tama ihu poro, the seventh from Tahu, the founder of the tribe. Shortly after his marriage Tu maro was called away for a time from Hataitai; and during his absence his wife, who was pregnant, contracted an improper intimacy with Te ao hikuraki. Tu maro returned just before his wife gave birth to a child, and, being ignorant of her misconduct, proceeded, when the pains of labour began, to repeat the customary charms to aid delivery. Having exhausted his store of charms, and repeated all the genealogies of his ancestors in vain, he

began to suspect that something was wrong, and questioned his wife, who, after a little delay, confessed that one of his relations had been to her. "But who was it?" he demanded. "Te ao hikuraki," she replied. The moment that name was uttered the child was born. Tu maro, without going near his wife, kept removing her from house to house till her purification and that of the child was accomplished. Then he came to her early one morning and told her to paint herself and the infant with red ochre; to put on her best mats, and to adorn her head with feathers. The woman did as she was bid, wondering all the time what her husband meant to do. When she had finished adorning herself, Tu maro led her into the court-yard of Te ao hikuraki, whom he found sitting under the veranda. "Here," said he, "is *your* wife and *child!*" and then, without another word, he turned away and went back to his own house. He then summoned all his immediate friends and relations, and informed them that it was his intention to leave the place immediately, as he could not live on friendly terms with those who had dishonoured him. His father approved of the proposed step, and acting on his advice their hapu, carrying with them their families and all their moveable goods, crossed the straits and entered Blind Bay, along the coast of which they sailed till they reached the mouth of the Waimea, where they landed and built a pa. Here, for upwards of twenty years, the Ngaitara, Ngatiwhata, and Ngatirua, sub-sections of the Ngai Tahu tribe, separated from their main body at Hataitai, grew into such importance through their alliance with Ngatimamoe, that they came at last to be regarded more in the light of independent tribes than parts of one and the same; and this often complicates the narrative.

But what serves to complicate still further the history of this period was the existence of small settlements in the sounds of natives from the west coast of the North Island including detachments of Rangitane, Ngatihauwa, Ngatihape, Ngai te he iwi, Ngai tawako, Ngati whare puka, and Ngai tu rahui. The Rangitane appear to have been the most important. Te Hau was their chief, and his cultivations at Te Karaka, known as Kapara te hau and O kainga, are still pointed out. Kupe, the great navigator, is said to have poured salt-water upon these cultivations for the purpose of destroying them, and so formed pools which remain to this day (?). These natives never seem to have extended their settlements much beyond the sounds, and little of their history worth recording has been preserved by the remnant of their descendants who escaped destruction at the hands of Te Rauparaha.

Beyond Waimea, the Ngatiwairangi and Ngatikopiha, who in common with Ngatimamoe and Ngai Tahu were descended from Tura, took up their abode and spread from there all down the west coast.

About twenty-five years after the secession of Kahukura te paku and his

followers, communication with Hataitai was reopened under the following circumstances. Tuahuriri, deserted in infancy by Tu maro, had now attained to man's estate, and had settled with his wives on the south-east coast of the North Island. But he could not rest till he had solved a question which had troubled him all his life. Once when a child he had been startled by hearing the mother of one of his playmates, whom he had struck, exclaim, "What a bullying fellow this bastard is." Running up to his own mother he immediately asked if it was true that he was a bastard. "No," she said. "Then where," he asked, "is my father?" "Look where the sun sets, that is where your father dwells." He kept these words treasured up in his memory, and now, having attained to man's estate, he determined to go in search of his father. Leaving his wives behind him he embarked with seventy men in a war canoe, and crossed the straits to Waimea; arrived there he landed and drew up the canoe in front of the pa. The inhabitants came forth to welcome him in and invited him to occupy the residence of their chief. On entering the house Tuahuriri laid himself down on his back near the door, whilst his companions seated themselves round the sides of the house. As no one in the place recognised any of them, the usual preparations were made for their destruction; as it was always held by Maoris that those who were not known friends must be regarded as enemies, and treated accordingly. Kahukura te paku stationed armed men all round the house, and while he was preparing to attack the new comers, the women and slaves were busy heating the stones and preparing the ovens to cook their bodies in. While these preparations were being made, and everyone was longing for the time when the bodies would be cooked and ready for them to feast upon, the children of the village came flocking round the entrance curious to see the strangers. One more venturesome than the rest climbed up to the window, and communicated to those behind him what he saw; while so occupied Tuahuriri looking up at the roof said "Ah, just like the red battens of my grandfather Kahukura te paku's house which he left over the other side at Kauwhakaarawaru." The boy on hearing this ran and told the men who were lying in wait. They made him repeat the words several times, and then Kahukura te paku said, "I never left any house or painted battens on the other side, only the boy on whose account we came across. Go, ask him his name." Then one arose and approached and called out, "Inside there. Eh! Sit up. Tell me who you are!" Then Tuahuriri sat up and said, "I am Te hiku tawatawa o te raki" (the name given to him by his father when he was born). The man went back and told Kahukura te paku, who was overwhelmed with shame when he discovered that he had been craving after the flesh of his own grandson. Approaching the house he told him to come forth, not by the door, but the

window, so that they might take the tapu off the wood and stones which they had got ready to cook him and his friends with, as the intention had defiled them. Having clambered through the window and embraced his grandson, Tuahuriri felt that he was safe; nevertheless he did not forget the indignity to which he had been subjected by his own relations, and he determined to take the first opportunity of punishing them for it. When returning to his own home with Kahukura te paku a few weeks afterwards, the people of Waimea begged Tuahuriri to come back and visit them in the autumn, when food would be plentiful, and they could entertain him more hospitably. But instead of doing so, he waited till he knew that they had planted their fields, and had nothing in their storehouses, then, taking one hundred men in addition to the seventy who went with him before, he re-crossed the straits. When he landed with all his followers the inhabitants of Waimea welcomed him very warmly, but apologised for the smallness of the quantity of food which they set before him, which, they assured him, was owing, not to inhospitality, but to the emptiness of their stores. When every particle of food in the place was consumed Tuahuriri returned home. Shortly after his departure the house he occupied was accidentally burnt down; the site of it was soon covered with a luxuriant crop of wild cabbage, which the people of the pa were driven by hunger to gather and eat, and in consequence of their doing so, they all died. For the greens were tapu, because grown on the site of a house once occupied by Kahukura te paku and his grandson. The colic produced by famished people gorging on greens proved fatal because the pain was attributed to the agency of the offended atuas of their chiefs. This incident throws light upon the frequent occurrence in past years of fatal effects arising from breaches of tapu.

The taking of Te mata ki kai poika is the next event of importance in the history of Ngai Tahu.

Tuahuriri had from some cause incurred the ill-will of a powerful member of his own tribe, the veteran warrior Hika oro roa, who assembled his relations and dependents and led them to the attack of Tuahuriri's pa, situated somewhere on the east coast. They reached the place at dawn of day, and as the leader was preparing to take the foremost place in the assault, a youth named Turuki, eager to distinguish himself, rushed past Hika oro roa, who uttered an exclamation of surprise and indignation, asking, in sneering tones, "Why a nameless warrior should dare to try and snatch the credit of a victory he had done nothing to win?" Turuki, burning with shame at the taunt, rushed back to the rear and addressed himself to Tutekawa, who was the head of his family, and besought him to withdraw his contingent and to attack the pa himself from the other side, and for ever prevent such a reproach from being uttered again. Tutekawa,

who felt the insult as keenly as his young relative, instantly adopted his suggestion; and so rapidly did he effect the movement, that his absence was not discovered before he had successfully assaulted the pa and his name was being shouted forth as the victor. Tuahuriri was surprised asleep in his whare, but succeeded in escaping, leaving his two wives, Hine kai taki and Tuara whati, to their fate. These women were persons of great distinction and were related to all the principal families in that part of the country, and their lives ought to have been quite safe in the hands of their husband's relations. But Tutekawa, who was a man of cruel disposition, finding the husband had escaped, killed both the women. As the war party were re-embarking a few hours after, Tuahuriri came out to the edge of the forest, which reached nearly to the shore, and calling Tutekawa, asked him if he had got his waist-cloth, belt, and weapons; on being answered in the affirmative, he begged that they might be given back to him. Tutekawa then stepped forward and flung them towards him. After picking them up, Tuahuriri threatened his cousin with the vengeance of his atuas for the injury he had done to him, and retiring into the depths of the forest he invoked the help of his familiar spirits, and by their agency raised the furious gale known as Tehau o Rongomai. This tempest dispersed Tutekawa's fleet, and many of his canoes were upset and the crews drowned. He with much difficulty reached the South Island, where to escape the vengeance of Tuahuriri, he decided to remain. He had nothing to fear for the Ngatimamoe, to whom he was related on the mother's side, and he knew that his presence would be still more welcome to them, because he was willing to turn his arms against the remnant of Waitaha who still maintained their independence. We now take leave of Tutekawa for some years, and return to trace the fortunes of the warriors at Hataitai, of whom we have heard nothing since Tu maro's secession.

Though constantly at war with their neighbours or quarrelling amongst themselves, they had succeeded hitherto in maintaining their ground; but certain events occurred after the fall of Te mata ki kai poika and the defeat of Tuahuriri, which ultimately led to their migration to the South Island.

The first was the marriage of Tiotio's two daughters to Te Hautaki, which was brought about in the following manner:—Te Hautaki, who was the chief of a hapu living at Kahu, and allied to Ngatimamoe, was one day driven out to sea from the fishing ground by a gale of wind. Fearing that his canoe would be upset, and being unable to get back to his own place, he tried to reach the opposite shore of the straits, and with much difficulty effected a landing after dusk at Whanga nui a tara, just below the Ngatikuri pa. "We are all dead men," he said to his crew, "unless we can reach the house of Tiotio unobserved." Tiotio was the upoko ariki, or

hereditary high priest of the tribe, and probably Hautaki regarded him in the light of a connection, since his son Tuteuretira was married to a Ngatimamoe woman and living amongst that tribe. "Is there any one of you," he asked, "who can point out this chief's house?" Fortunately one of the crew had been before to Hataitai and was able to act as guide. Having drawn up their canoe, they all marched noiselessly in single file till they reached the remotest of the chief's houses, which were distinguished from others around them by their great height and size. Passing by those of Maru, Manawa, and Rakai tauwheke, they came to that of Tiotio. Entering the house they found his wife seated beside a fire near the door, and the old man himself lying down at the farthest end. Roused by the noise of their footsteps, the old chief stood up and asked who they were, Te Hautaki replied "It is I." No sooner were they aware who it really was than the old wife set up a cry of welcome, but she was instantly checked by her husband, who dreaded the consequence of rousing the pa, and begged her not to attract attention, as that would endanger the lives of the whole party. He then told her to set food quickly before them, as they could not be killed after having been entertained as guests by the chief tohunga of the tribe. In obedience to his wishes, she placed a poha of preserved koko before them, and when they had finished their meal, she went over with a message from her husband to Rakai tauwheke, who was married to two of their daughters, Tahupare and Rongopare. That chief, in hearing of Te Hautaki's arrival, asked whether he had been allowed to eat in his father-in-law's house; on being answered in the affirmative, "That is enough," he said, "I will come and see him in the morning." Before doing so, however, he sent to inform Manawa and Maru and others, and as soon as what had happened became generally known throughout the pa, the warriors assembled round Tiotio's house, and with yells and frantic cries hurled their spears against the roof and sides, and behaved as if they intended to pull the house down. When old Tiotio remonstrated with them, they ceased their violence, and invited Te Hautaki to come out to them, when there was much talking and speech-making of a friendly kind, which finally ended in a proposal that Tiotio's remaining daughters—Rakai te kura and Mahanga tahi—should be given in marriage to Te Hautaki. As all the parties concerned were agreeable to this, the marriage took place without any delay. The Ngai Tahu chiefs asked many questions of their visitor about his house in the other island, and were so favourably impressed with his answers, that many responded to his invitation to accompany him when he returned. The final migration, however, did not take place till some time after Te Hautaki's return.

Last Migration.

What caused the step to be taken was this: Tapu, a Kahununu chief,

heard those who had seen Rakai tauwheke's house at Hataitai praising the workmanship of it, and, being jealous, said—"What is his house to my Kopapa, which will carry me along the backbone of Rongo rongo." These words coming to Rakai tauwheke's ears, were interpreted by him to mean a curse, and when Tapu afterwards came on a visit with some friends to Hataitai, Rakai tauwheke fell upon him and killed him, but spared all his companions, whom he allowed to return safely home. But dreading the vengeance of Tapu's tribe, the Ngai Tahu abandoned Hataitai, and crossed over the straits in a body to Moioio, an island in one of the sounds close to Kai hinu, where there was a mixed settlement of Ngaitara and Ngatimamoe. Here they lived peaceably with their neighbours for some time till their anger was aroused by the discovery that they had joined in eating the corrupted body of a Ngai Tahu man which they had found in the forest, where, unknown to his friends, he had died. This was considered a very gross insult, and was avenged in the following manner:—Someone was sent to fetch the leg and thigh-bones of Te ao Marere, a Ngaitara chief, whose remains had been lately discovered in a cave by some Ngai Tahu women when gathering flax on the slopes of Kaihinu. Out of these bones hooks were made, and when Ngaitara went out to fish a Ngai Tahu man, taking one of the hooks, went with them; and when the fish greedily attacked the bait, and were drawn up to the surface in rapid succession, he said, in a tone to be heard and remarked, "How the old man buried up there nips." The words were noted, and it was agreed that they could only refer to the desecration of their chief's grave, and to set the question at rest a person was sent to examine it, when it was found that part of the skeleton had been removed. As the Ngaitara did not regard this as a justifiable act of retaliation for their having eaten the body which they found, they determined therefore to avenge it. An opportunity of doing so was afforded to them shortly afterwards, when a party of Ngai Tahu women came as usual to the neighbourhood of Kai hinu to gather flax. While they were busily employed at their work, the Ngaitara attacked and killed the whole of them, amongst whom was the daughter of Puraho. This chief mourned sorely for his child and vowed to avenge her; but before he could do so, he was himself killed by the same people, who, feeling that they had incurred the vengeance of Ngai Tahu, were resolved to follow up what they had done and to be the first in the field. Observing from the mainland, which was only a short way off, that Puraho and Manawa went every morning at dawn to perform certain offices of nature at a particular spot where they had dug two holes together for the purpose, it was arranged to plant an ambush near the spot to lie in wait for them. Accordingly, during the night, two warriors were sent to secrete themselves in the holes, where,

hidden by the cross beams, they awaited the coming of the doomed men. At break of day the two approached; Puraho being in advance was the first to turn and sit on the beam, and Manawa was about to do the same, when he was startled and prevented by the uprising of the warrior under Puraho, who killed that chief by a sudden blow on the back of the head. Manawa immediately fled and escaped into the pa.

The death of Puraho convinced Ngai Tahu of the insecurity of their position at Moioio, and they determined to abandon it and to remove to O te Kane, at the mouth of the Wairau river, where they built a strongly fortified pa. As soon as they had provided for the safety of their families, they began to take measures for avenging the death of Puraho, and the women so mercilessly slaughtered by Ngaitara.

Commencement of War with Ngatimamoe.

They first attacked a neighbouring pa, and captured it. Amongst the prisoners was the chief Te Rapa a te kuri, who was brought by his captors to Maru, in order that he might have the satisfaction of putting him to death as utu for his father and sister. But contrary to their expectations, and to the annoyance and disgust of everyone, Maru spared the prisoner's life. Waitai was so exasperated by his culpable leniency, that he immediately withdrew with 800 followers, and sailed away to the south, settling for a time at Pukekura. On taking his departure he warned those who remained against a leader who would encourage them to attack his enemies and then deprive them of their right to put their captives to death. "I will never again join with Maru," he said, "but will fight my enemies where I shall not be interfered with." Though considerably weakened by the secession of Waitai, Ngai Tahu wished to continue the war, but were opposed by Maru, who, being related to Ngaitara, did not like to see them crushed. While the Ngai Tahu chiefs were disputing about their future plans, Te Kane and Tau hiku went out one day to fish, in order to silence the cries of their grandchildren for a change of food. They had not gone far from the shore when both canoes were enveloped in a fog; the crews could hear the splashing of the paddles, but could not see each other; they succeeded, however, in reaching the fishing ground, and Tau hiku was the first to drop his anchor, and just as Te Kane was about to do the same, he became aware that they were being pursued, and that the sound of paddling proceeded from canoes sent after them by Ngatimamoe. Te Kane turned at once and pulled towards the shore, but Tau hiku was surrounded and taken prisoner. A running fight was then maintained between Te Kane's canoe and Ngatimamoe. The fog prevented the position of affairs being seen from the shore, where Ngai Tahu were in complete ignorance of the danger their friends were in, though, as the canoes approached the land, sounds of strife reached their ears.

Te Kane managed to keep the enemy from coming to close quarters by the help of his nephew, who, acting upon his instructions, watched his opportunity whenever they came close enough to seize the man nearest to him, jerk him on board his own canoe, and kill him by cleaving open his skull; and as his blood spirted out over his comrades, they drew back with horror, and gave Te Kane a slight advantage in the race. This was repeated again and again till they got quite close to the shore, when the fog rose and discovered the combatants to the people of the pa, who were wondering what it could be that was causing such a din. Manawa and others ran down to the landing place, where they saw Tau hiku, their tohunga, lying bound in the bottom of the Ngatimamoe canoe, which had pursued Te Kane to within a few yards of the beach. The Ngai Tahu were overwhelmed with grief and alarm, and wailed forth their last farewell to the old priest doomed to fill the enemy's oven; in acknowledgment of their parting cries, he held up two fingers.

Ngai Tahu were paralyzed by the loss of their wisest tohunga, for there was no one to take his place—no one who could read the omens and tell the propitious time for attack, or forewarn them of approaching danger. The chiefs assembled and continued long in anxious consultation. "Have we no one," they asked, "of the race of Tau hiku who can enlighten us—one with whom he has left his knowledge?" They called his daughter and questioned her. She advised them to summon Tau hiku's son Pohatu, but they ridiculed the idea; he had never displayed any talent, and had from boyhood consorted with slaves in preference to persons of his own rank. "Can such a one as Pohatu enlighten and direct us? His place is in the kitchen beside the cooking fire; what can the defiled know about sacred things!" Still his sister urged that he might be sent for and questioned; so at last they took Pohatu, and, having stripped him of his clothes, they took him to the water and cleansed him, and then performed certain incantations over him to consecrate him and make him "tapu." When the ceremonies were completed they asked him what Tau hiku meant by holding up two fingers. "Two years," he replied. "You must wait for that time before you attempt to avenge his death, in order that the grass may hide the oven in which he was cooked."

During this period of forced inaction, the Ngai Tahu were particularly anxious to know what their enemies were doing, and in this they were greatly assisted by a man named Kiti, who was related to both tribes, and who by common consent acted as spy for both. Kiti alarmed the Ngai Tahu with the reports he brought to them of the formidable preparations being made by Ngatimamoe for the coming struggle. Besides the ordinary weapons, they had prepared spears pointed with the barbed and poisonous

sting of the ray—of which everyone appeared to stand in great dread. As the time approached for commencing hostilities, all hearts were filled with alarm, and as this feeling of dread increased the older chiefs felt that something must be done to counteract it, or their defeat and destruction were certain. They decided, therefore, to take the initiative, and to commence hostilities at once. Then Maru rose and called upon the veteran warriors, the heroes of former battles, to recount the story of their deeds so as to inspire the tribe with courage :—"Rise up, Te Kane, and tell the people what thou achieved at Whanga nui a tara!" But Te Kane kept his seat, and replied: "Ah! that was accomplished in the midst of thousands supporting me, but here, single-handed, what can I do!" Turning to another, he said: "Rise up, O Manawa, and tell the story of thy brave deeds at Waihao!" But Manawa only repeated Te Kane's words: "They were done amidst supporting thousands." One after another the heroes were appealed to, but all in vain; till Maru turned to Rakai tauwheke: "Rise, O Wheke!" "Yes," he said, "I will; since all these brave men decline, I will force the way—I will charge the foe—I will lead the people on to victory! Rouse thyself, Pohatu! Rouse thyself, O seer! Dig the wells, rear the mounds that you may see how the tatare (dog-fish) of Tane moehau (his mother) will burst the nets!" The bold bearing of Rakai tauwheke revived the drooping spirits of his tribe. His words inspired them with courage; and the omens given by Pohatu decided Ngai Tahu to attack the enemy at once. They swarmed up the hill-side that separated them from the pa; but Ngatimamoe, thanks to Kiti, were well informed of their movements, and before they could reach the top, came pouring over the ridge, filling the air with their yells of defiance, and raining down their dreaded spears upon the advancing ranks. Rakai tauwheke kept well in front, and succeeded in warding off every weapon aimed against him, and finally reached the top of the hill, where he was soon joined by others, and there, by a prodigious display of valour, he completely routed the enemy, who broke and fled in every direction. Tu te uretira pursued after Tu ma taiao, a Ngatimamoe chief married to a sister of Maru, and would have caught him but for an accident to his foot, which obliged him to give up the chase. As he did so he called out to his flying foe: "It is only this painful foot prevents my overtaking you." To which the other sneeringly replied: "Are you the one who can catch by morning the moving foot, swift as the raupo swaying in the wind?" "Ah!" said Tu te uretira, "Can you escape by morning the cutting toetoe of Turau moa?" No vain boast, as he afterwards proved.

Among those who fell upon this occasion was Kana te pu, who had sadly misread the omens. In his island home at Rakiura he dreamt that he

caught a white crane, which kicked him in the chest while vainly struggling to get free. Interpreting this dream to mean that he was destined to overcome some famous Ngai Tahu warrior, he went to a neighbouring stream to bind the omen, and then eager to distinguish himself summoned his followers and took his departure for the seat of war. In the crisis of the battle when Rakai tauwheke was slaying those to the right and left of him with his taiaha, Kana te pu, watching his opportunity, sprang upon his shoulders, and held him so firmly that he could not draw his arms back again. He tried in vain to shake him off, but by a sudden movement of his hands he jerked the point of his weapon against the head of his opponent, and then, by a violent contortion of the body, succeeded in inflicting a mortal wound, and the white crane fell dead at his feet.

After the defeat of Ngatimamoe at Te Whao, or battle of the ray-barbed spears, peace was restored for some years, and Ngai Tahu were permanently settled at Wairau.

But trouble was brewing for Ngatimamoe in a quarter whence it was least expected.

For many years two Ngai Tahu chiefs had lived amongst them, and having married their women were regarded as being thoroughly identified with them. One appears to have been of a moody sullen disposition whilst the other was quite the reverse, and made himself so popular that he was elected chief of the hapu with whom he lived. Apoka lived a solitary life with his two wives and a few slaves while Tu te uretira ruled a pa containing three hundred Ngatimamoe. Apoka's ground was too poor to cultivate and game rarely frequented the woods in his neigbourhood. He was forced to depend for subsistence on fern root. He bore his privations cheerfully till his suspicions were aroused that his wives partook of better fare than they chose to set before him. He daily noticed that their breath gave evidence of their having eaten some savoury food. He remarked that although they paid frequent visits to their relatives who resided at a place celebrated for the variety and plenty of its supplies, they never brought anything to vary the sameness of his diet. He was convinced these visits were made to replenish secret stores concealed from him by his wives at the suggestion of their people, who perhaps thought that if he once tasted the good things of Waipapa he might advise his tribe to take possession of it by force. His wives when questioned indignantly denied that they ate anything better than the food given to their lord. Convinced, however, that they deceived him, and brooding over his wrong, he resolved to seek his cousin's advice. On drawing near the settlement he found Tu te uretira in the midst of a large kumera plantation urging on the labours of a hundred men. His cousin asked whether he should cause the men to desist from

their work and to adjourn to the pa to listen to whatever he might have to say. "No," replied Apoka, "my business is with you alone, let the men continue their work." The two then visited the tuahu, where they performed certain rites, and then retired to the veranda of the chief's house, where one of his wives had arranged some food for the refreshment of the visitor. Tu te uretira blessed the food, and then invited his cousin to partake of it, begging him to refresh himself, and then tell him his business before the people returned from the field to prepare a feast in his honour. Apoka bent his head a long time in silence, and then said, "I am stupefied, I am amazed at the variety of food;" then pointing to each basket before him in succession he asked what they contained. He then resumed his silence, and fixing his eyes on the ground remained in that position for some hours. He was roused from his reverie by the arrival of the tribe bringing the feast they had prepared, and which they set down in little piles before him. He made the same answer to all their pressing invitations to eat, "I am overcome, I am astonished, I cannot eat." "But how is it," enquired his cousin, "that you who married Ngatimamoe women should express such astonishment at the every-day fare of that people, surely you enjoy the same advantages as myself by your connection with them?" In reply Apoka told him his suspicions respecting his wives, which had received confirmation by what he had seen during his visit. Tu te uretira advised him to refer the matter to the elders of the tribe at Wairau who would be only too glad to take up his quarrel that they might dispossess Ngatimamoe of Waipapa. Apoka, satisfied with the advice, rose and returned fasting to his home, where his wives brought him the usual meal, of which he partook, and then retired to rest. To lull any suspicions that might arise respecting the object of his visit to Wairau, he set off for Waipapa early the next morning accompanied by a slave bearing his fishing tackle. The canoes were already launched when he arrived, and all the men were about starting on a fishing expedition. On seeing him, however, the principal chief of the place gave immediate orders that the canoes should be drawn up, and that everyone should return to the pa out of respect to his son-in-law. But when Apoka assured him that his only object in coming was to go with them, and that he would be disappointed unless they went, the canoes were manned and they all started for the fishing ground. Only two fishes were caught, and these by Te Apoka. The whole party were much annoyed at their want of success, and regarded it as an ill omen. On landing, his friends begged Apoka to remain and partake of their hospitality, but he refused to stay and ordered his servant to bring the fish and to follow him. The first thing he did when he got home was to hang the fish up on the tuahu as an offering to his atua. He then ordered his wives to prepare a quantity of fern-root as

he intended to take a long journey. When his arrangements were completed, he took one fish, and fastening it to the end of a rod, bore it on his shoulder to Wairau. His tribe no sooner saw him than they recognized the symbol which indicated a troubled mind, and immediately guessed his errand. They gave him a hearty welcome and crowded eagerly round to hear the story of his wrongs. As he detailed the various circumstances their indignation rose higher and higher, and when he proposed to lead them against the Ngatimamoe young and old shouted with delight. It was agreed that the close relationship existing between himself and his wives shielded them from punishment, but that the insult they had offered must be wiped out by the blood of their tribe. Fearing to go near Tu te uretira lest the enemy should be warned, they took a very circuitous route and came upon the doomed pa at dawn. Apoka knowing it was the custom of the place to go early every day to fish, placed his men in ambush round the pa; directing Uhikore, a warrior famed for his bravery, to lie in wait under the principal chief's canoe. His arrangements were scarcely completed before Paua himself appeared. He was a very tall man, and so powerful that, unaided, he could launch a war canoe. He placed his shoulder against the bow of his canoe to push it as usual into the water, when Uhikore rose and felled him to the ground. The cry that Paua was killed struck terror into the hearts of the Ngatimamoe, and ere they could recover themselves the place was stormed and taken. A few only escaped; the rest were either eaten or reduced to slavery.*

Apoka, whose hatred seemed implacable, resolved to destroy that portion of Ngatimamoe over whom Tu te uretira ruled. He sent Uhikore clothed in the spoils of Paua to inform him of his design. As he approached, the garments he wore were recognized by Paua's relations, who bewailed his sad fate with loud lamentations. Deserted by Tu te uretira, who returned with Uhikore to the camp of his victorious countrymen, and dreading an attack, the Ngatimamoe abandoned the settlements, and fled down the coast towards Kaikoura, where they remained undisturbed for some years. Having chosen a strong position at Peketa, on the hill-side at the mouth of the Kahutara, they built a fortified pa, and being joined by other sections of the tribe, they were emboldened to attack a fighting party of the Ngai Tahu. They succeeded in capturing all the canoes but one, that of Te Kane, which escaped with the loss of the most of the crew. This led to a renewal of hostilities between the two tribes; a battle was fought at Opokihi, and again on the banks of the Kahutara, in both which engagements Ngatimamoe were defeated. They then retired within their fortifications, and Ngai Tahu laid siege, but failed for many months to effect an entrance. A council of chiefs

* Fall of Waipapa is placed by some before the battle of Ika a whaturoa.

was then held, at which Rakai tauwheke proposed to draw the enemy out by stratagem. His plan was approved of, and he proposed to carry it out on the following morning. Putting on two feather-mats, and armed with a patu paraoa, he went before dawn to the beach, and entering the surf threw himself down and allowed the waves to carry him backwards and forwards, occasionally raising his arm a little that it might appear like a fin. The sentinels soon took notice of the dark object in the water, which they concluded must be either a seal or a young whale. The cry of "He ika moana! he ika moana!" brought the whole pa to their doors, and a general rush towards the beach followed, each striving to secure the prize. The pa was so close to the shore that the people did not hesitate to open the gates, and the foremost man plunged into the surf, but before he could discover his mistake the supposed fish rose and struck him dead. The alarm was immediately given, and the crowd fell back within the stockade and the scheme failed. Weakened and wearied by the war, the two tribes laid down their arms and made peace, which continued till broken by Manawa's raid on Omihi.

The Ngatimamoe at that place were partly ruled by Takiauau, a Ngai Tahu and nephew of Te Rangi whakaputa, who was related to the former tribe on the mother's side. For some reason Manawa attacked these people. Having approached the pa with six companions for the purpose of reconnoitring, he caught sight of the tu ao kura, or head ornament of Rakaimomona, father of Tukiauau, who was sitting outside his house. Manawa hurled a spear in that direction and pierced the old man through the heart, then without being aware of what he had done, he returned to join the main body of his followers, resolving to attack the pa at dawn. Within the pa all was confusion, the death of Rakaimomona produced a panic, and it was decided to evacuate the place during the night, but in order to conceal their intentions from the enemy, they left fires burning in every house. Manawa, ignorant of what had happened, cautiously approached at dawn to invest the place, but not seeing anyone moving about, he sent scouts to the top of a neighbouring hill from which the pa could be overlooked, and they soon returned with the intelligence that the place was deserted. Manawa immediately returned to Waipapa and reported what had happened to Maru, who offered to follow the fugitives and to bring them back; *his secret reason for doing this being that his Ngatimamoe connections might have an opportunity of avenging Rakaimomona's death at some future time.* He found Tukiauau at Tutae putaputa where he was preserving his father's head, which he intended to keep, according to custom, at one end of his house, where, surrounded by mats, he and his children could look upon it, and think the old man was still amongst them. Maru urged Tukiauau not

to go any further, but to build his pa where he was, at Pakihi. This he consented to do, and Maru returned home. Not long afterwards a circumstance occurred which indicates the existence of such a curious state of things, that it is hard to understand how any tribe could exist when subject to such internal disorders, and where its leading members were animated by such opposite motives.

Maru's daughter Rakai te kura was betrothed in infancy to Te Rangi tauhunga, son of Te Rangi whakaputa; notwithstanding this, she married with her father's consent Tu a keka; this so incensed Te Rangi whakaputa that, on hearing of it, he went straight to Maru's enclosure and killed one of his servants, Tu manawa rua, right before his face. So gross an outrage could not be patiently borne, and Maru sought the protection of Tukiauau with whom he remained till Te Rangi whakaputa was forced by the Ngai Tahu, who regretted the absence of a favourite chief, to go and ask him to come back. On his arrival at Pakihi Maru presented him with a large poha or kelp-vessel full of preserved birds, which was called Tohu raumati. Te Rangi whakaputa, while accepting it, refused to allow it to be opened, saying, "It shall be for you Maru when you return to us." As soon as Maru did reach Waipapa he proposed that the poha should be eaten on the war path, as they had a death to avenge. Maru could not kill the man who insulted him, nor any of his people, but he hoped that in fighting the common enemy some of Te Rangi whakaputa's kin would be killed, and so payment for his murdered servant and injured honour would be obtained. Ngai Tahu, always eager for war, responded to his invitation and followed him to the attack of Kura te au, a pa belonging to Ngaitaka. It was taken, and amongst the prisoners was Hine Maka, a woman of rank, who was brought to Maru in order that he might put her to death; but instead of doing so he gave her in marriage to his son, and when asked the reason for this strange act his reply was, "When my descendants, the offspring of this marriage, are taunted with being slaves on the mother's side, the particulars will be enquired into, and then it will be found that the mother was taken prisoner when the death of my father was being avenged, so that the memory of my father's death having been avenged will be better preserved by sparing this woman than by killing her."

It was about this time that Ngai Tahu had a visit from a celebrated Ngatimamoe chief Te Rangitauneke, who lived at Ohou near the Opihi river. He came as the champion of his tribe for the purpose of challenging Manawa to single combat with spears. But Manawa's friends would not allow him to accept the challenge, fearing that he might be killed. Maru, however, was allowed to take it up, and at the appointed time, in the presence of the assembled warriors, the two chiefs encountered each other.

Rangitauneke was the first to hurl his spear, which Maru parried; then Maru, not wishing to kill him, threw his spear in such a manner as to pass between his legs and through his apron. Te Rangitauneke acknowledged himself beaten and returned home, where he was, shortly after, reported to be killed at Upokopipi, having been surprised by his enemies while sleeping with a woman in the grass outside his pa. His atua matamata, however, came to his rescue and licked up his blood, when he recovered and re-entered the pa, now in his enemies' hands; having routed them he set fire to the place, and retired with friends towards the south, where, after many encounters with Ngai Tahu, he eventually died at Waihopai.

During the peace which followed the taking of Kura te au, the most friendly intercourse existed between the various Maori communities; to such an extent did this prevail that Manawa even ventured to visit Tukiauau, whose father he had killed a few years before. The object of the visit was to see the far-famed beauty Te ahua rangi, daughter of Tu whakapau, with a view to making at some future time a proposal of marriage on behalf of his son Te rua hikihiki. He did not conceal from his own people that he hoped, by means of this marriage, to secure the Ngatimamoe hapu, to which the beauty belonged, as his son's serfs. The idea tickled the fancy of his followers, who, while employed fastening the side-boards of his canoe preparatory to his departure, could not refrain from joking about the people who were so soon to become their chief's pori. "Eh! this is a grand idea," said one. Ah! said another, "wait till you have successfully snared the thick-necked bird of Hika roroa." The visit passed off pleasantly, and Manawa was returning home; the people were flocking to the beach side of the pa to wish him good-bye, when Te Rangi whakaputa hearing some one sobbing, turned round and saw it was Tukiauau. "Are you a woman that you cry?" "No," said he, "I am only grieving at my brother's departure." "Beware!" was the reply. "Do not use green flax, but whitau. Do not take the foremost nor the hindermost, but the one in the middle, kopu para para, the star of the year himself. Do not divulge this hint of mine." The suggestion, so treacherously made by Manawa's friend and companion in arms, was not forgotten, as the sequel will show. Having waited an appropriate time, Manawa returned to Pakihi to obtain the formal consent of Tu whakapau to his daughter's marriage with his son. Accompanied by 100 followers he approached the pa, being welcomed with the customary greetings. Amongst his party were Maru's brother and several other relations of his; these were led by Hine umutahi to her house, while the rest were shown into a large house set apart for their reception. Manawa was the last to enter the pa, and as he bent his head in passing through the low gateway, Tukiauau, who was standing just inside it, struck him a violent blow with

a stone axe. Manawa staggered forward, but before he reached his companions he received a still more violent blow on the head. Immediately he got into the house the door was closed, and the old chief, after wiping the blood from his face, addressed his men. He told them that their case was hopeless. Caught in a trap and surrounded by overpowering numbers they must prepare to die; all that he desired was that an attempt should be made to convey to the Ngai Tahu tidings of their cruel fate. Many volunteered for the dangerous service. One having been chosen from the number, Manawa, after smearing his forehead with the blood from his own wound, charged him to be brave, and committing him to the care of his atuas sent him forth. Hundreds of spears were aimed at the messenger, who fell transfixed before he had advanced a pace. Again and again the attempt to escape was repeated, but in vain. The imprisoned band grew dispirited, and Manawa failed to obtain a ready response to his call for more volunteers. At length a youth closely related to him offered to make a last attempt. The moment was propitious; the enemy, certain of success, guarded the door with less vigilance. Smeared with the dying chief's blood, and charged with his last message to his family and tribe, Tahua sprang forth; warding off the spears hurled at him and evading his pursuers among the houses and enclosures he reached the outer fence, over which he climbed in safety and turned to rush down the hill. But the only path bristled with spears. His enemies were pressing upon him. One chance for life remained. The pa stood on the edge of a cliff; by leaping down upon the beach below he might escape. He made the attempt; and a shout of triumph rose from his foes when they saw his body extended upon the sands; but their rage knew no bounds when he sprang up, and in a loud voice defied them to track the swift feet of the son of Tahu. To allay the suspicions of those whom he met as he fled along the coast, he gave out that he was returning for something forgotten at the last camping-place, and thus successfully passed on to Waipapa. The Ngatimamoe now proceeded to kill and eat the victims of their treachery.

The Ngai Tahu were quite unmanned by the startling intelligence brought by Tahua. After Manawa's friendly reception on a previous visit to Pakihi, they were unprepared for this act of revenge for the death of Tukiauau's father. They determined to let a year pass before they avenged the death of their chief, fearing lest a panic might seize them should they fight too soon on ground where blood dear to them had been so recently spilt. They preferred waiting till the grass had overgrown the oven in which Manawa was cooked, and hidden all traces of his sad fate. When that time arrived a war party was summoned, and it was decided to proceed by sea. All the chiefs except Te Kane were ready on the appointed day, and he was told to

follow. Vexed at being left behind he urged his men to hasten the fittings of his canoe, and as soon as they were completed he launched forth and sailed in quest of his friends. On the second day he saw their fires, but passing by them landed on a point which served to conceal his canoe, but from which he could watch the Ngatimamoe pa. Seeing the enemy leaving the shore to fish in the morning he waited till they anchored, and then, issuing from his retreat, charged down upon them. He succeeded in capturing one canoe, and having killed all on board except the chief, he rowed back to the place where he had last seen his comrade's fires. They took him at first for an enemy and were not a little surprised when they recognized the very man whom they were waiting for. Seeing he had a prisoner, they called to ask who he was. "Tukaroua," replied Kane. "He is my brother-in-law," shouted Maru, who came running down to the edge of the water with a mat* to cover him. Kane, fearing his life would be spared, stooped down and bit off his right ear and ate it. "Oh! oh!" cried the man. "Aha," said Kane. "Did Manawa cry out when he was struck?" and stooping down, he bit the other ear off. The brother-in-law seeing Kane's determination to retaliate Manawa's death upon the prisoner, reluctantly gave him up to be eaten.

The next day Ngai Tahu laid seige to Pakihi, but its strong position baffled every effort made to take it. Food failed besiegers and besieged. The Ngai Tahu were about to retire, when Tu te rangi apiapi *who was related to persons in the pa*, hit upon a plan for its destruction. Without divulging his design he asked permission to visit the Ngatimamoe for the ostensible purpose of offering conditions of peace. He was well received by the besieged and his visits became frequent and long continued. The Ngai Tahu grew impatient at the delay and wanted to know how he was to effect his object. "Wait," he said, "till a nor'wester blows, and then seize the opportunity afforded to you." When the wind blew from the desired quarter, Tu te rangi apiapi went as usual and seated himself in the doorway of a kauta, near the lower end of the pa and on the windward side. Having procured one of the long stones with which the women prepared the fern-root, he fastened one end to a piece of green flax and put the other into a fire; when it was red hot he watched his opportunity and slung it into the thatch of an adjoining house. A cry of fire soon arose. The unsuspected perpetrator of the deed rushed out to assist the crowds who were trying to extinguish the flames, but in his apparent haste to pull off the burning thatch, he threw it in such a manner that the wind might blow it on to the other houses, and in a few moments the whole place was involved in the

* If a chief wished to spare a particular prisoner he threw one of his garments over him.

conflagration. Under cover of the smoke, the Ngai Tahu entered and a general massacre ensued. Amongst those who fled was Tu mataiao. Tu te uretira, mindful of his former boast, pursued after him, and this time caught him. "Let me live," he begged. "Ah! was it not you who said I could not catch by morning the feet moving like the swift quivering raupo? Come with me to the camp." Arrived there, Maru beckoned for Tu mataiao to be brought to his side, where he made room for him upon his mat. The poor wretch thought his life was now safe, when to his dismay Maru the merciful rose up, and, addressing the tribe, said—"Here, take your food, only take care first to burn off the skin that has nestled beside that of your sister." Tu mataiao was then seized and put to death and eaten.

Weakened by successive defeats the Ngatimamoe gradually retired southwards, and we do not hear of their making any very determined stand between the fall of Pakihi, or Pari whakatau, and the great battle on the banks of the Aparima thirty years afterwards, when their forces were completely annihilated, although constant petty encounters between the two contending tribes continued up to the very last. It was during this interval that the fugitives from Pakihi are said to have lived in caves, where traces of their occupation are shown in the rude drawings overlying those of a more ancient date; the reason given for their choosing such temporary shelter being that they thought they were less likely to be attacked, and if they were they would be in a better position to escape. Tukiauau, who escaped with his son and a few followers, separated from the main body of fugitives and went down to the Waihora lake where he built a pa. While there his son Koroki whiti made the acquaintance of Haki te kura, the daughter of the chief whose pa stood at the mouth of the Taiari. This maiden, unknown to her friends, used to meet her lover on the sands when the tide was low, and these clandestine meetings continued up to the time of Tukiauau's departure further south; for, hearing rumours of Ngai Tahu movements, he became alarmed and determined to place himself beyond pursuit. Accordingly he abandoned his pa at Waihora and embarked with his followers in a large war canoe. As they were passing below her father's pa, Haki te kura, eager to join her lover, jumped off the cliff into the water, but in doing so either fell upon a rock or on the edge of the canoe and was killed. Tu wiri roa, overwhelmed with grief and rage, swore to destroy the man who was the cause of his daughter's death. Waiting for a while to lull suspicion he followed in Tukiauau's wake, but could not for a long time discover his retreat, which was at length betrayed by the smoke of a fire on the island of Rakiura. Concealing himself behind some islets he waited till a canoe, manned by a large number of persons, came out to fish;

when they had anchored, and their attention was fixed upon their lines, Tu wiri roa bore down upon them and cut off their escape. Taken unawares without their weapons the crew were easily overpowered and put to death, and all their companions on shore soon after shared their fate.

Waitai.

It does not appear that Waitai, after separating himself from the main body of Ngai Tahu and fixing his residence in the south, was ever as successful in his encounters with Ngatimamoe as those whom he deserted; whilst they made a clean sweep of their opponents driving them steadily down the coast before them, Waitai seems to have been content to plant stations here and there amongst Ngatimamoe without attempting their subjugation. We find him in alliance with Te Rangi tau neke, and joining with him in expeditions against Te Kapuwai or Waitaha who were still numerous inland. Thirty years after the conquest of the northern part of the island, Ngatimamoe were still so strong in the south that they threatened the existence of the Ngai Tahu settlements there.

Amongst the most noted chiefs who followed in Waitaha's wake was Te Wera, who for a time occupied a strong position at the mouth of the Waikouaiti river. He is more distinguished for his achievements against his own tribe in the south than against the common enemy. He finally settled at Rakiura, where he lived principally on seal's flesh and grew very fat. At the "Neck" a place called "the Fright of Te Wera" is pointed out where his first encounter with a seal took place; when he confessed that he, who never knew what fear was in any battle with men, felt terrified then. On his death-bed he advised his family to return to the main land, "that they might lie on a fragrant bed, and not on a stinking one like his." An oven in his estimation being preferable to a grave."

Wharau nga pu raho nui.

We now enter on the second period of the Ngai Tahu occupation, the first having closed with the fall of Pakihi and the dispersion of its inhabitants. The invaders now held entire possession of the country from Wairau southwards as far as Waihora, and occupied fortified pas here and there throughout the Ngatimamoe country as far south as Rakiura.

The second period opens with the arrival, about the year 1727, of a party of young chiefs at Kaiapoi, known as the Wharaunga puraho nui, or colonising noblemen, consisting of the sons of the principal Ngai Tahu chiefs, some of whom had been brought up in the other island by their Kahununu relations. Amongst them were the sons of Turakautahi. This chief had selected Kaiapoi as his residence, where he established a reputation for hospitality—a virtue which on his death-bed he enjoined his posterity to continue for ever the practice of.

Taking Possession of the Land.

These young chiefs having ascertained from persons familiar with the physical features of the country the names of the various localities, proceeded to divide the unallotted part of the country amongst themselves. And their procedure on this occasion is of particular interest, as it serves to illustrate one method by which the Maoris acquired title to land.

Kakapo skins were at that time highly prized, and every one of the party was desirous to secure a preserve for himself. As they approached the mountain known as Whata arama, they each claimed a peak of the range. "That is mine," cried Moki, "that my daughter, Te ao tukia, may possess a kilt of kakapo skins to make her fragrant and beautiful." "Mine," cried Tane tiki, "that the kakapo skins may form a kilt for my daughter Hine mihi." "Mine," cried Hikatutae, "that the kakapo skins may form a girdle for my daughter Kaiata." Moki, one of the party, had his servant with him, who whispered in his ear, "Wait, do not claim anything yet;" and then the man climbed up into a tree. "What are you doing?" said the rest of the party. "Only breaking off the dry branches to light our fire with;"—but he was in reality looking out for the mountain Turakautahi had told his master was the place where the kakapo were most abundant. Presently he espied the far-famed peak. "My mountain Kura tawhiti!" he cried. "Ours!" said Moki. The claim was at once recognized by the other members of the exploring expedition, and Moki's descendants have ever since enjoyed the exclusive right to hunt kakapo on Kura tawhiti.

Hostilities against Ngatimamoe were renewed on the arrival of these young chiefs and the infusion of new blood into the Ngai Tahu war counsels. An expedition under the command of Moki was sent in the canoe Makawhiua against Parakakariki on the south-eastern side of the peninsula. After destroying that pa Moki returned to Koukourarata, where he landed and proceeded over the hills to Waikakahi, where Tu te kawa, who killed his grandfather's wives, was still living, though now a very old man. This chief, whose flight south has already been mentioned, settled first at Okohana because eels were plentiful there, but finding those of Waihora were of a better quality, he removed to the shores of that lake, and built a pa at Waikakahi, while his son Te Rangitamau built another at Taumutu. Surrounded by his allies and at such a great distance from his enemies, Tu te kawa thought himself quite safe; but the avenger of blood was already on his track, and he was doomed to die a violent death. The shadow of Moki's form across his threshold was the first intimation of immediate danger which the Waikakahi people had. The old chief, infirm and helpless, was found coiled up in his mats in a corner of his house, and a natural impulse prompted Moki and his brothers at the last moment to shield their

kinsman, but the avenger of blood thrust his spear between them, and plunged it into the old man's body.

Having ascertained that Te Rangitamau was away at Taumutu, and not knowing what course he might take, Moki gave orders that a watch should be kept during the night round the camp to guard against surprise, but his orders were disregarded. Te Rangitamau, whose suspicions were aroused by observing a more than ordinary quantity of smoke arising from the neighbourhood of his father's pa, set off at once for the place, which he reached after dark. Passing through the sleeping warriors he approached his father's house, and looking in saw his wife Puna hikoia sitting by the fire. Stepping in he touched her gently on the shoulder, and putting his finger to his lips as a signal to keep silence, beckoned her to come outside. There he questioned her about what had happened, and finding that she and his children had been kindly treated, he told his wife to wake Moki after he was gone, and to give him this message, "Your life was in my hands, but I gave it back to you." Then taking off his dog-skin mat he placed it across Moki's knees, and hurried away to his own stronghold on the hill close by. When Puna hikoia thought her husband safe from pursuit, she woke Moki and gave him the message. Moki felt the mat, and was convinced the woman spoke the truth. He was greatly mortified at being caught sleeping, as it was always injurious to a warrior's reputation to be discovered off his guard. Issuing from the whare he roused his sleeping followers with the words which have since become proverbial, "Ngai tuwhaitara mata hori." O, deaf-eared Tuwhaitara! The next day negociations were entered into with Te Rangitamau and peace restored between him and his kinsmen.

West Coast Maoris. Discovery of Greenstone.

It is not till the Ngai Tahu conquests reached Horowhenua that we hear anything of Ngati Wairangi, the tribe occupying the west coast, who, like Ngatimamoe and Ngai Tahu, were descendants of Tura, and crossed over to this island almost the same time with them. Hitherto they had been shut off from communication with the east coast by what were thought to be impassable natural barriers, till a mad woman named Raureka discovered a way through them. Wandering from her home this woman went up the bed of the Hokitika river, and then across what is known as Browny Pass, and thence down to the east coast. There in the neighbourhood of Horowhenua she came upon some men engaged in shaping a canoe, and taking notice of their tools remarked how very blunt they were. The men asked if she knew of any better. She replied by taking a little packet from her bosom, which she carefully unfolded, and displayed a sharp fragment of greenstone. This was the first the natives there had ever seen, and they were so delighted with the discovery that they sent a party immediately

over the ranges to fetch some, and it subsequently came into general use for tools and weapons, those made of inferior materials being discarded. Raureka's packet marks a period, though not a very distant one, seeing that if she was a co-temporary of Moki she arrived at Horowhenua about 1700.

It does not follow from this account of the discovery of greenstone that it was unknown to all in the North Island, for the Hawaikians acquired their knowledge of the existence of New Zealand from Ngahue, whose god was a sea-monster called Poutini. A woman named Hine tuaohoanga caused this man to be driven away from Hawaiki. He rode on the back of his sea-monster to Tuhua; but being pursued thither by Hine tuaohoanga, he passed on to Ao-te-aroa (North Island); but fearing it was too close, continued his voyage and settled at Arahura, where he discovered the greenstone, which was valuable enough to ensure him a safe return to Hawaiki, and it was with axes made of this greenstone that the canoes were shaped in which the first immigrants arrived. There is strong presumptive evidence that this story is a myth, but it is just possible Ngahue's monster may have been a proa or junk, as European vessels, when first seen, were called atuas by the Maoris. The descendants of Maru tuahu at Hauraki show a hei tiki, which they say he wore when he arrived in New Zealand. It has been handed down from generation to generation, being alternately in possession of his Taranaki and Hauraki descendants. It is quite possible, too, that traffic in greenstone between Ngati Wairangi and the North Island tribes bordering on Cook Straits may have been in existence for many years before it became known to Ngai Tahu.

The discovery of greenstone brought Ngati Wairangi into collision with Ngai Tahu, and blood was shed. To avenge this, Turakautahi asked Te Rangitamau to undertake the command of an expedition, which he accepted. The route chosen was up the Rakaia, with which locality Te Rangitamau was familiar. Somewhere between Kanieri and Kokatahi he fell in with Te Uekanuka, a chief celebrated as much for his enormous size as for his great courage, whom he killed. Having accomplished his object Te Rangitamau returned. The next expedition was attended with very disastrous results, being defeated by Ngati Wairangi at Mahinapua, where Tane tiki, Tu te pirirangi, and Tutae maro were slain; the survivors with difficulty effecting their retreat.

To avenge this loss a third expedition was sent under the command of Moki and Maka, who defeated Ngati Wairangi at Otuku whakaoka.

The struggle between the two tribes continued till within the last fifty years, when Tuhuru and his brother Te Paro overcame Ngati Wairangi at the battle of Paparoa, and, assisted by Te ao whakamaru and Puku, completed their destruction. The present residents on the coast are Ngai Tahu.

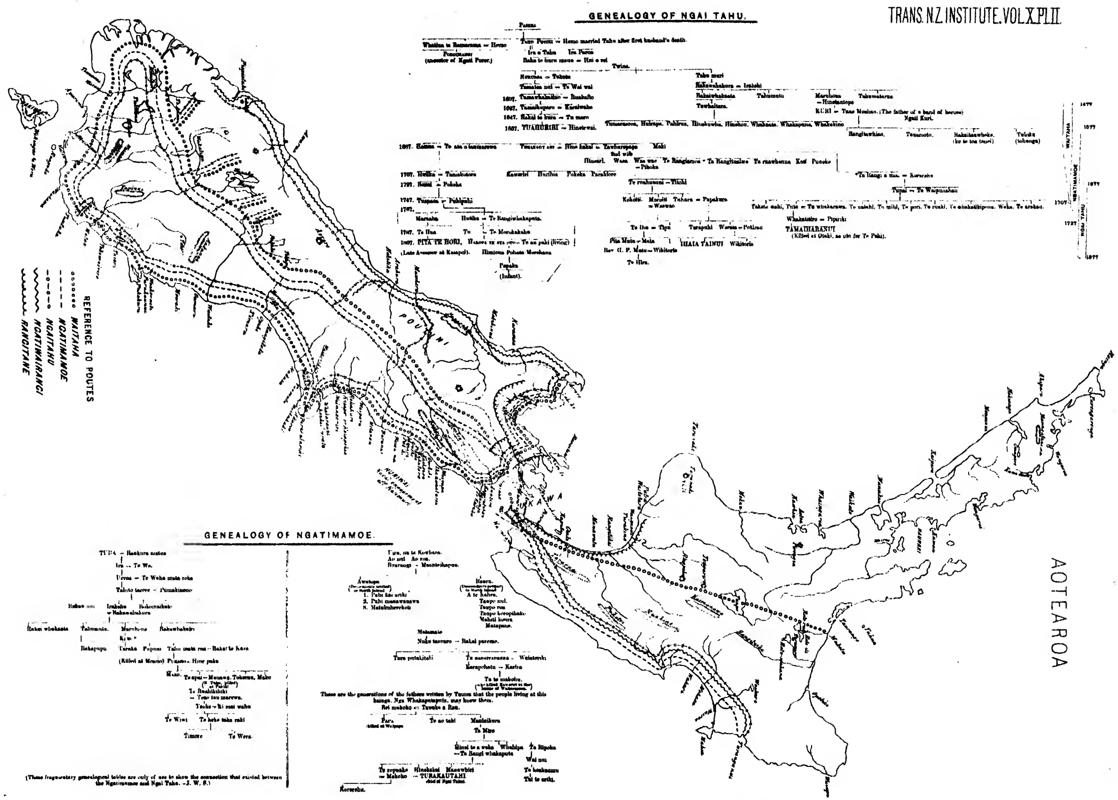
Raid on the South.

The sons of Turakautahi, who were eager to emulate the brave deeds of the Hataitai warriors, determined to follow up their successes and complete the conquest of the Ngatimamoe. They planned a raid on the south, and Kaweriri was placed in chief command. On crossing the Waitaki the force divided into two parts, one proceeded by an inland road, the other along the coast; by this manœuvre they succeeded in driving those of the Ngatimamoe who were not in alliance with Ngai Tahu hapus before them, till they reached Aparima, where, at Tara hau kapiti, or Wai tara mea, they were brought to bay. Both sides displayed the greatest courage, and for a while the issue of the struggle was uncertain. To the consternation of Ngai Tahu, their leader and foremost warrior, Kaweriri, was mortally wounded by Tu te makohu, and for a moment they wavered, but observing that they rallied again, that chief dreading the consequences of his deed retired from the field; but he was observed and pursued by a young warrior, Te mai werohia, who thought to earn a reputation by avenging the death of his leader. Hearing the sound of footsteps Tu te makohu turned and asked who it was that was following him. On hearing the name and recognizing it, he asked whether his pursuer was the son of Kiri teka teka (a relative of his own married to a Ngai Tahu). When told that he was, he said "Turn back, lest you fall by the hand of your mother's kinsman." In the meantime Parakiore having recovered from the shock produced by his brother's death, was now in hot pursuit of Tu te makohu, and this parley afforded the opportunity of overtaking him. The fugitive was making his way up a steep hill-side, and already heard the hard quick breathing of his pursuer when he invoked the aid of his atua, who caused a friendly mist to descend and hide him from pursuit: reminding us of the scene on the plains of Troy, when Menelaus with vindictive strides rushed again

> "On Paris spear in hand, but her involved
> In mist opaque, Venus with ease divine
> Snatched thence."

Ngatimamoe being defeated retired some miles up the river, where they took up a fortified position, and being still superior to their assailants in number hoped to make a successful stand. But their hopes were doomed to disappointment, for in a few days they were again attacked, and after a desperate resistance defeated with great slaughter at Teihoka, where, till quite recently, the bleaching bones witnessed to the numbers of the slain. The few who escaped fled into the forests towards the west, across the lake Te Anau.

Those portions of the tribe scattered along the coast from Otakou to the sounds, were in the course of a few years destroyed or absorbed into the


GENEALOGY OF NGAI TAHU.
GENEALOGY OF NGATIMAMOE.
AOTEAROA
REFERENCE TO ROUTES
WAITAHA
NGATIMAMOE
NGAITAHU
NGATIWAIRANGI
RANGITANE

Ngai Tahu; and the Ngatimamoe, as a distinct and independent tribe, may be said to have perished at Teihoka. Those in alliance with Ngai Tahu were still numerous, but their position was felt to be so insecure that, on the return of Turakautahi's sons from their successful raid, Te Rangi ihia, a noted Ngatimamoe chief residing at Matau, determined to proceed to Kaiapoi and make lasting terms of peace with the conquerors. He was kindly received; and to cement the treaty then made, Hine hakiri, one of the ruling family of Ngai Tahu, was given to him in marriage; and his own sister, Kohiwai, was married to Hone kai, son of Te Hau. Rangi ihia resided with his wife's relations till after the birth of his son Pari, when they advised him to return, as it was their wish to embody Rangi ihia's hapu with their own and to make the boy chief of both. Te Hau and Turakautahi's sons escorted Rangi ihia to the south. On reaching home he was shocked to see one of his sisters cooking food like a common slave. When leaving her behind, he had taken care to provide such attendance as befitted her rank, and he could not account for her being reduced to such straits as to be obliged to cook her own food. Suppressing his indignation till night-fall, he took the opportunity when all was quiet of asking her why she had so demeaned herself. She then told him that, after he left, her maids married and deserted her. Seizing his weapons, Rangi ihia having ascertained where they were to be found went to the house occupied by the runaways and killed both the women. As he turned his back to go out again, one of the husbands drove a spear into his shoulder, the point breaking off against the bone. On reaching his own whare, Te Hau pulled this out with his teeth, and applied a tootoo plaster to the wound. While Rangi ihia was recovering, he unfortunately sneered at the weakness of the arm which had struck him: "Had it been my own the thrust would have been fatal." This coming to the ears of the injured men, they scraped the end of the spear and got off the dry blood adhering to it, and, by performing incantations over it, produced symptoms of madness in Rangi ihia, who shortly afterwards died. Before his death, he turned to his friend Te Hau and said, "When I am gone, do not let my brothers live; they are bitter men, and will slay my children." It was at Otepoti where he was being treated for his wound and died. His brothers and their people were camped at a short distance off on the other end of the bay. On calling out one day to ask how the patient was, their suspicions were roused by the way in which the answer was given. The person replying called out, "He is——," and then paused suddenly as if being remonstrated with, finishing the sentence by saying—"gone with his wife and children." Ngatimamoe entered the Ngai Tahu camp shortly after, when Te Hau, mindful of the dying chief's charge, fell upon his brothers, Taihua and Te Rangiamohia, and killed them.

Te Rangi ihia was buried in accordance with his own desire on the peak Te raka a runga te raki, "that his spirit might see from thence his old haunts to the southward." His wife and children were sent back to their friends in the north, while Te Hau took up his quarters at Pukekura.

Final Destruction of Ngatimamoe.

Many years after Rangi ihia's death, his bones were carried down by a landslip to the beach, where, being picked up by a Ngai Tahu, he made a fish-hook of one, and when using this made some insolent remark about the old man on the hill holding the hapuku well. A Ngatimamoe who was present reported the words to his companions, who remarked, "The two brothers died in open fight, but this man has been dishonoured after death, and the insult must be avenged." An opportunity occurred shortly after for accomplishing their meditated act of retaliation. A party had been sent from Pukekura to Rauone to collect fern-root. There Tane toro tika, son of Taoka and grandson of Manawa, a young chief of very high rank, was surprised and taken prisoner; on being carried to the presence of Te Maui, that chief seeing him said, "This comb-fastening is equal to that comb-fastening," and thereupon killed him. Tai kawa, a Ngai Tahu warrior, immediately after the deed, came upon the band of Ngatimamoe and asked what had become of the prisoner. When told that they had killed him, he said, "You have done foolishly, for not a soul of you will now be spared; you will be banished to the haunts of the Moho, and in the depths of the forest will be your only safety."

This threat was soon after carried into effect by Te Hau, who, after a series of engagements, drove the remnants of Ngatimamoe into the dense forests that cover the south-western coast, where further pursuit was useless. Traces of these fugitives have been met with up to a very recent date.

About fifty years ago Te Rimu rapa, while on his way to plunder a sealing-station, discovered a woman who called herself Tu ai te kura; finding that she was a Ngatimamoe, he cruelly killed and devoured her on the spot. About six years afterwards Te wae wae surprised two men while he was out eel-spearing near Aparima, but they escaped before he could catch them. In 1842 a sealing party, while pulling up one of the sounds, observed smoke issuing from the face of a cliff. Climbing to the spot they found a cave evidently just deserted. It was portioned across the middle—the inner part being used as a sleeping place, the outer for cooking. They found a handsome feather-mat, a patu paraoa, some fish-hooks, and some flax-baskets in process of making. An attempt was made to pursue the late inmates, but it had to be abandoned, for the undergrowth in the forest was so dense, and the paths so numerous, that the pursuers were afraid of

being lost in the maze or falling into an ambuscade; they, therefore, returned to the boat, carrying with them the articles they found in the cave. These were exhibited at Otakou, the Peninsula, and Kaiapoi. The mat was sent to Otaki, and the patu paraoa was eventually given to me by Te muru, an old chief at Port Levy.

Aperahama Hutoitoi of Nga whakaputaputa affirms that four years ago, when sealing in the sounds, he saw smoke in the distance, and visiting the spot the next day observed the footprints of several persons on the sands, evidently Maoris from the shape of the feet.

Having suffered so cruelly from Ngai Tahu, the survivors of the persecuted tribe seem to be always in a state of flight, imagining that their ancient foes are still in pursuit. Though the country has of late years been well explored by "prospecting" parties without any people being found, it is just possible that a small remnant may still remain secreted in the recesses of that inaccessible region.

Internal Dissensions.

No sooner were they freed from anxiety about the common foe than old feuds revived, and fresh quarrels broke out between the different hapus and sections of hapus of the Ngai Tahu, till the whole country presented such a scene of anarchy and strife, that it is hardly possible to give a connected account of the innumerable petty contests which took place at this period.

One event which occurred on the peninsula, and which is almost comic in its ghastliness, will serve as a specimen of the warfare in those times. Ngatiwairua and Ngai Tuwhaitara being involved in a quarrel, Te Wera took up the cause of the former, and in the fight at Tara ka hina a tea killed Kiri mahinahina. This man was a tohunga who taught history incorrectly. It was he who told the younger Turakautahi that Tiki made man, whilst the fathers had always said that it was To. Te Wera adopted a novel method of preventing his teaching surviving him or his spirit escaping and perverting the mind of any other tohunga. Having made an oven capable of containing the entire body, he carefully plugged the mouth, nose, ears, and rectum, and then cooked and ate the heretical teacher.

The history of Ngai Tahu from this period till the taking of Kaiapoi by Te Rauparaha in 1827, is but a repetition on a smaller scale amongst themselves of the scenes enacted during their struggle with Ngatimamoe, and may very well be omitted from this paper, which does not profess to be anything more than a brief sketch. It may prevent misapprehension if I here state that in tracing the history of Ngai Tahu, I have purposely avoided alluding to the exploits of particular hapus,—a favourite practice of the Maori annalist, but fraught with confusion to the European reader, who would be sorely puzzled amongst the multiplicity of so-called tribes, to know which

belonged to the invaders and which to the invaded. I have classed the allies, hapus, and sections of hapus of each tribe under one common appellation: Maoris may say I am wrong, but I appeal from them to the common sense of my English readers, and am hopeful of their verdict in my favour.

Art. VI.—*On the Influence of the Earth's Rotation on Rivers.*

By A. C. Baines.

[*Read before the Philosophical Institute of Canterbury, 4th October*, 1877.]

In his address to this Institute, delivered on April 5th, 1877, Dr. von Haast devotes some space to the explanation of the important fact that rivers, whose banks are composed of loose materials, wear away their right banks in the northern hemisphere and their left in the southern, at the same time building up the opposite banks.

Dr. von Haast gives an account of the theory of Von Baer, who first showed that the observed changes in the courses of rivers might be explained as a consequence of the earth's rotation. Von Baer's explanation depends upon a well known mechanical theorem, by which the westward motion of the trade winds had previously been accounted for, and which may be thus stated—"A body moving on a meridian tends to be deflected towards the right in the northern hemisphere, and towards the left in the southern, in consequence of the change in its eastward velocity as it approaches or recedes from the earth's axis." The change in the eastward velocity, it is necessary to observe, accounts for only a part of the deflecting force. The direction of motion in space is also changing as the earth revolves. A railway truck moving on a meridian in the southern hemisphere has its line of motion turned round in the same direction as that of the hands of a watch. There must consequently be a pressure against the truck towards the right, and an equal pressure against the rails towards the left, which must be added to that caused by the change of eastward velocity.

The explanation given by Von Baer does not account for the fact that where the course of a river is east and west the banks are worn away in the same manner as where the course is on a meridian. To explain this it must be shown that a body moving at right angles to the meridian tends to be deflected.

A body resting on the earth's surface, and free to move in any direction upon it, is maintained in equilibrium by attraction directed towards the earth's centre, and centrifugal force directed away from the axis. If the

centrifugal force ceased, the body would evidently move towards the nearest pole, as down a hill. From the poles to the equator may therefore be regarded as up-hill—bodies free to move being prevented from going down towards the poles by centrifugal force. Suppose, now, a body to move from west to east, that is, in the same direction as the earth revolves; the centrifugal force of the body is increased and there is a tendency to move up-hill, towards the equator. If the motion be from east to west, the centrifugal force is diminished, and the body tends towards the pole. In each case the tendency is towards the right in the northern hemisphere and towards the left in the southern.

The deflecting force arising from the earth's rotation being a horizontal force acting always at right angles to the direction of motion, its effect on a stream in the southern hemisphere must be to raise the water-level at the left bank and lower it at the right, and this difference of level by increasing the depth would increase the velocity, and consequently the erosive power at the left bank. It might appear that the wearing away of the left banks of rivers in the southern hemisphere is thus accounted for, but examination will make it evident that this explanation is insufficient. It will be shown that the difference of level at the opposite sides of a stream in lat. 45°, whose mean velocity is three miles an hour, is $\frac{1}{71023}$ of the width, which in a stream a mile wide is only $\frac{9}{10}$ inch. The effect of the small difference in the erosive power, due to that difference of level—in causing unequal wearing away of the banks—would be neutralized, if the left bank were composed of slightly harder material than the right; or if the left bank were a little higher, so that the quantity of material to be removed for each foot cut away horizontally would be greater than at the right. The small difference of erosive power could not explain how it is that, as a general rule, the bank which is being worn away is much the highest, the opposite bank being, in many rivers, below flood level, especially when it is taken into consideration that the material below the water-line at the high bank has been consolidated by superincumbent pressure, and made more compact and difficult to break up than the loose recent deposit of the river, of which the low bank consists. Take for instance the lower course of the river Rangitata, where there is a high terrace on the left, and a low plain on the right. The erosive power at the left bank would have to be many times, instead of a small fraction, greater than at the right, to account for the high terrace being cut away instead of the low plain.

I shall try to show that the changes in river-courses are due to the unequal velocities of the surface and bottom layers of running water.

In ordinary streams the velocity increases nearly uniformly from the bottom to the surface, the deflecting force being proportional to the

velocity of the moving water. The water near the surface is urged towards the left bank with greater force than that near the bottom. To ascertain the kind of motion caused by these unequal forces:—Suppose the stream to be straight, of uniform cross-section, to be everywhere of the same depth, and imagine it to be divided into a great number of layers parallel to the surface, each moving with different velocity. Then, the increase of pressure against the left bank, due to the earth's rotation, equals the sum of the deflecting forces, which sum is the same as if the mean deflecting force acted on every layer. Therefore, the water-level at the left bank is raised to the same height, and the surface-line of the cross-section is inclined to the horizon at the same angle as if the mean deflecting force acted on every layer, and the tangent of the inclination is the latter force divided by the force of gravitation.

The accompanying cut shows the cross-section of a stream, the angle A being very much exaggerated.

Let a be a small cube of water in any part of the cross-section whose volume is $dx\ dy\ dz$.

h, h_1 the depths below the surface of the centres of the left and right sides of the cube respectively.

f, f_1 the deflecting forces acting on the cube a and on a similar cube in the middle layer respectively.

w, the weight of an unit of volume of water.

A, the angle of inclination of the surface of the stream from left to right.

F, the resultant force acting on the cube a.

Then $$F = w\,(h - h_1)\,dy\,dz - f$$
$$= \tan A \,.\, w\,dx\,dy\,dz - f$$

And $$\tan A = \frac{f_1}{w\,dx\,dy\,dz}$$

Therefore $F = f_1 - f$

That is, the resultant force acting on a particle in any part of the cross-section is the difference of the deflecting forces acting on that particle and a particle in the middle layer. This quantity is of different sign for particles situated above and below the middle line, showing that the resultant force acts in opposite directions, above and below that line. These forces must evidently cause a circulation, as shown by the arrows in the figure, which motion will be combined with that down the stream, so that the actual motion of any particle is inclined at a very small angle to the direction of the channel. It is clear that a very slow motion of the bottom layer from left to right must cause a transfer to the right side of the

river-bed of shingle and sand rolled along by the current. The effect of this is plainly to make the right shore more shelving and the left steeper, and to place the deepest part of the stream nearer the left bank. This will cause the velocity and consequently the erosion to be greater at the left bank. The right shore being more shelving will be more favourable to the deposition of sediment during the subsidence of floods. The continual building-up of the right bank explains how a river cuts away on its left bank harder material than that of which the right is composed; while the latter, instead of being cut away, is being added to. The wearing away of a high terrace instead of a low flat on the opposite side of the river is similarly explained.

The principal facts in connection with the changes of river courses are thus accounted for, which a minute difference in the erosive power at the opposite banks of rivers, caused directly by a difference of level, appears inadequate to explain.

To find the deflecting force acting on a body moving on the earth's surface in any direction:—

Let p be the position of the body on the great circle $A\,A'$, the inclination of whose plane to the plane of the equator is a, the motion of the body being towards A'. Let $O\,A'$ be the axis of x, $O\,C$ the axis of z, that of y being perpendicular to the plane of the paper.

Let θ be the angular velocity of the earth round the polar axis $P\,P'$; θ_1, θ_3, the angular velocities round the axes of x and z respectively.

$$\text{Then } \theta_1 = \theta \sin a, \quad \theta_3 = \theta \cos a$$

$$\text{Let } x = r \cos \phi, \quad y = r \sin \phi$$

r being the radius of the earth, and ϕ being measured from the axis of x towards that of y.

$O\,p\,D$ being a spherical triangle, and the angle D a right angle, $\sin p\,D = \sin a \cos \phi = \sin \text{Lat.}$

The equations of motion of a particle, referred to axes moving in any manner about a fixed origin, are—the mass being unity,—

$$X = \frac{du}{dt} - v\theta_3 + w\theta_2 \qquad u = \frac{dx}{dt} - y\theta_3 + z\theta_2$$

$$Y = \frac{dv}{dt} - w\theta_1 + u\theta_3 \qquad v = \frac{dy}{dt} - z\theta_1 + x\theta_3$$

$$Z = \frac{dw}{dt} - u\theta_2 + v\theta_1 \qquad w = \frac{dz}{dt} - x\theta_2 + y\theta_1$$

Therefore

$$X = -2\frac{dy}{dt}\theta_3 - x\theta_3^2 \qquad = -2\,\theta V \cos a \cos \phi - r\,\theta^2 \cos^2 a \cos \phi$$

$$Y = -2\frac{dx}{dt}\theta_3 - y\theta_1^2 - y\theta_3^2 = -2\,\theta V \cos a \sin \phi - r\,\theta^2 \sin \phi$$

$$Z = \quad 2\frac{dy}{dt}\theta_1 + x\theta_1\theta_3 \qquad = \quad 2\,\theta V \sin a \cos \phi + r\,\theta^2 \sin a \cos a \cos \phi$$

$$= \quad 2\,\theta\,V \sin \text{Lat.} + r\,\theta^2 \sin a \cos a \cos \phi$$

V being the velocity of the body on the earth's surface.

The terms in X, Y, Z, not containing V, are the forces parallel to the axes, acting on a body at rest on the earth's surface. Their resultant is therefore balanced by centrifugal force, and reaction of the earth's surface. The terms containing V in X and Y, being resolved along the tangent at p to the great circle $A\ A'$, cancel, showing that the earth's rotation has no effect in accelerating or retarding a moving body. The term in Z, $2\,\theta\,V$ sin Lat. represents a force acting in a tangent to the earth's surface, and at right angles to the line of motion of the body, the positive sign showing that the constraining force is directed towards the left, the body having an equal tendency towards the right which is the deflecting force.

Let the mean velocity of a stream be three miles an hour (the stream being assumed to be everywhere of the same depth, and the velocity to be equal at equal depths below the surface), then the deflecting force being proportional to the velocity, the mean deflecting force acting on the stream is that due to a velocity of three miles an hour, and it has been shown that the angle of inclination of the surface line of the cross-section to the horizon, is that whose tangent is the mean deflecting force divided by the force of gravitation $= \frac{f_1}{g}$ suppose—

And $\frac{f_1}{g} = \frac{2\,\theta\,V \sin \text{Lat.}}{g}$ where θ is the angular motion of the earth per second which is 0·0000729

V = 3 miles an hour or 4·4 feet per second

Sin Lat. = sin 45° = 0·707

$$\text{Then } \frac{f_1}{g} = \frac{2 \times 0{\cdot}0000729 \times 0{\cdot}707 \times 4{\cdot}4}{32{\cdot}2} = 0{\cdot}00001408$$

$$= \frac{1}{71023}$$

which multiplied by 63360, the number of inches in a mile, gives $\frac{9}{10}$ inch nearly, which is the difference of level at the opposite sides of a stream a mile wide.

ART. VII.—*On a peculiar Method of Arrow Propulsion as observed amongst the Maoris.* By COLEMAN PHILLIPS.

[*Read before the Wellington Philosophical Society, 1st September,* 1877.]

WHILE lately in the Upper Thames District, at Ohinemuri, I observed some Maori boys playing with an arrow. The peculiar method of propulsion arrested my attention, never having seen or even heard of the like before. The following is a brief description of the process:—

The arrow was about nine inches in length, shaped like a mustard-spoon, and roughly carved out of a piece of white pine (kahikatea). The shaft was square and contained a small notch about two and a half inches from the point.

The bow consisted of a piece of manuka, about three feet in length and half an inch in diameter, quite straight, but elastic. The string was attached to one end of this stick, the two together forming a perfect whip. A knot was tied at the end of the string, which was merely a common piece of twine.

The mode of propulsion consisted in—1st. Holding the arrow in the left hand; 2nd. Placing the string in the notch in the arrow; and 3rd. Whipping the arrow into the air, or at any desired object. The boys at play were, apparently, not very skilful performers, although one of them managed to hit a duck at twenty yards. When sending the arrow into the air a much greater distance was easily attained.

I have since made many enquiries into the matter in order to discover the origination of this peculiar method, but I have met with little success. The plan appears to be purely a native one, although I know of none similar among the inhabitants of the South Seas, Polynesians or Melanesians. In itself it is a harmless weapon, and how it happens that the Maoris—a section of the Polynesian race—should have thus allowed so useful a weapon as the South Sea bow-and-arrow to degenerate into a mere toy is to me a curious circumstance.

In the course of my enquiries, I believe that I have discovered a reason for cutting the notch in the arrow. It is well known that in olden days the Maoris launched their spears against a hostile pa by means of a whip similar to the one above described, and they were even able to hurl stones a long distance. In these instances the projectile was laid upon the ground and the end of the whip made fast round it, by taking one turn and casting back the little knot at the extreme end of the string. This sufficiently well fastened the whip, but immediately the jerk forward was given the string

cleared itself; the weapon retaining the full force of the original impetus. A much greater distance could, I believe, be attained by this method than by hand-throwing. I have been shown two or three different ways of fastening the whip, but in each case, even when two or three turns were taken, the projectile cleared itself more or less readily. It, therefore, appears to me that the plan of notching the arrow was devised in order to avoid the necessity of taking a turn with the whip; a method more liable to foul. I have given such an arrow into the hands of a more southern native, who took little notice of the notch, but immediately made one turn round the shaft of the arrow as above described. I should also state that many natives to whom I have shown the arrow appear to have forgotten its use, but immediately I explained the matter they readily understood it.

I have deemed the subject worthy of being brought before the notice of this society, as it is one which should not be allowed to pass unrecorded. I have often wondered how it is that the aborigines of New Zealand should have made so little use of the bow-and-arrow, this being a weapon peculiarly suited to savage tribes, and, moreover, the familiar one of their ancestors. I believe that Maori tradition points to its use, but I have been unable to discover the existence of any such weapon even in our museums. It is also peculiar that the Maoris, ignorant as they appear to be of the ordinary bow-and-arrow, should still possess the strange method of propulsion above described. Whether the whip is an adoption of the ancient sling is a question. A similar method may exist among some of the inhabitants of the South Sea Islands, but I have not met with it. If it does, I trust it will be pointed out, as the ethnological analogy will be useful.

Mr. Colenso, in his able essay on the "Maori Races of New Zealand,"* makes no reference to the bow-and-arrow. That writer speaks of "long and short spears, and especially of bird spears," which were very long, "some being upwards of thirty feet and made of the light-wood, tawa (*Nesodaphne tawa*). They also made darts with heads of light combustible materials; these they used in attacking a pa or village." No mention is made as to the manner by which these darts were projected. I imagine by one of the modes hereinbefore described.

With regard to spears, I may mention that some of them could be projected a very long distance, fully 100 to 130 yards. The end of the spear was stuck lightly in the ground, the head pointing toward the desired direction. The whip was then made fast and the spear propelled. Such a spear would be about twelve feet long, made of a hard wood, with a large head and tapering end, polished by constant rubbing in a sand or gravel bank, first one end and then the other. This method of propulsion is very

* "Trans. N.Z. Inst.," I.

similar to the one mentioned, except sticking the end of the spear in the ground. I have also seen a native stick an arrow in the ground and then whip it into the air. As to the bird spears referred to by Mr. Colenso, I am only aware of one, viz, the "pigeon spear." This was made out of a piece of rata vine 30 to 40 feet in length, and more resembled a stiff piece of rope than a spear, it being perfectly flexible, and could be easily trailed through a thick bush—a very desirable acquirement. The head of this spear was formed out of one of the human leg bones *(fibula)*, both sharpened and jagged. The person using this spear would slowly raise it, balancing it as it swayed about, immediately under the bough of the tree upon which the pigeon sat, until the point came within a few inches of the bird, then by an upward thrust impaling it. So stupid is the pigeon that even now it will see its mate shot within a few feet of where it is sitting, perhaps on the same branch, and in many instances never attempt to fly away. A shorter hand spear may have been used when trapping the brown parrot. All those weapons, however, fell into disuse after the introduction of fire-arms some sixty years ago, which may account for the disappearance of the bow-and-arrow. I think a more extensive paper upon this subject would be of service. I have only endeavoured to record a curious method of propulsion which arrested my attention.

[Note.—See also Sir G. Grey in "Polynesian Mythology," p. 157; Thomson, in "Story of New Zealand," Vol. I., ch. VII; White in "Te Rou," p. 116. Ed.]

Art. VIII.—*On the Day in which Captain Cook took formal Possession of New Zealand.* By W. Colenso, F.L.S.

[*Read before the Hawke Bay Philosophical Institute, 13th August, 1877.*]

For several years I have been of opinion that all our colonial almanacs are in error on this subject. They all give the 15th of November, 1769, as the day in which Cook took possession of New Zealand in the name of the King. This they have always done, and in this they have been followed by other publications, both Colonial and British, when speaking of the circumstance. My object in bringing this matter in a few words plainly before you is to initiate an enquiry, which, whether I am right or wrong, will serve to settle the question. And I have good reasons for believing that what I shall state will cause you all to agree that, at least, there is considerable doubt about it.

The almanac makers and others, as I have said, give the 15th November, 1769, as the day, and Mercury Bay as the place in which this act was done, and, to a certain extent, they are right, viz., that on that day, according to what is related in Dr. Hawkesworth's narrative of Cook's first voyage, such a circumstance took place. The words are as follows :—

"Before we left the bay, we cut upon one of the trees near the watering-place the ship's name and that of the commander, with the date of the year and the month when we were there; and after displaying the English colours, I took a formal possession of it in the name of His Britannic Majesty King George the Third."*

And here I may remark, in passing, that this sentence stands alone as a short paragraph added on at the end of the chapter; after we had been told of their having left the bay, and of their having been obliged through contrary winds to change their course at sea.

Dr. Hawkesworth, who was employed to edit this first voyage of Cook, says in his introduction that he was largely indebted to Mr. (afterwards Sir Joseph) Banks, for much of his scientific, popular, and interesting information; indeed, as it would appear, to a far greater extent than to Capt. Cook himself, from whom, however, were derived "the particular account of the nautical incidents of the voyage, the figure and extent of the countries, with the bearings, harbours, soundings, the latitudes, longitudes, and variation of the compass, and such other particulars as lay in his department." And, in still plainer language, the editor further says: "As the materials furnished by Mr. Banks were so interesting and copious, there arose an objection against writing an account of this voyage in the person of the commander, the descriptions and observations of Mr. Banks would be absorbed without any distinction in a general narrative given under another name: but this objection he generously overruled, and it therefore became necessary to give some account of the obligations which he has laid upon the public and myself in this place."

I quote this rather fully, because, as I think, it will partly serve to show how the error (if an error) came about. For it must not be forgotten that Captain Cook did *not* himself write his *first* voyage as we have it printed and published; neither was he in England during the time of publication, and consequently knew nothing whatever of it until three or four years afterwards.

Having said so much by way of introduction, I shall now give you my reasons for supposing an error to exist. I propose, therefore, to consider:

(1.) Cook's usual custom in taking possession of any newly-discovered country.

* 4to edn., vol. II, p. 348.

(2.) The length of time he was in New Zealand before the day in question.

(3.) What has also been published respecting Cook's taking possession of New Zealand by a fellow-voyager and witness of the transaction.

(4.) What may possibly have been the real meaning of the paragraph quoted.

(First.) Cook's usual custom in taking possession of any newly-discovered country.

This is clearly shown, I think, from what took place but a few months before, namely, on the 20th July. He says:—"We now made sail from the island of Huaheine for the island of Ulietea, distant seven or eight leagues, and when the day broke the next morning we stood in for the shore, and anchored in twenty-two fathoms. * * * We determined to go on shore without delay. * * * * I landed in company with Mr. Banks, Dr. Solander, and the other gentlemen, Tupia being also of the party. He introduced us (to the natives) by repeating the ceremonies which he had performed at Huaheine, after which I hoisted an English jack and took possession of this and of the three neighbouring islands, Huaheine, Otaha, and Bolabola, which were all in sight, in the name of His Britannic Majesty." Cook remained here at anchor, "trading with the natives and examining the products and curiosities of the country," four or five days.

(Second). The length of time he was in New Zealand before the day in question (November 15th).

Cook, as is well known, first saw New Zealand on the 6th of October, and landed on its shores on the evening of Sunday, the 8th, on which occasion a Maori was unfortunately killed. On the next morning Cook landed again in three boats with a large party, and spent some time on shore, when, unhappily, several Maoris were killed, as well as some others on the sea when returning to the ship. And on the following day Cook and others with him again landed, and spent some time on shore shooting ducks and collecting plants. After this Cook sailed southwards, coasting close in shore, round Table Cape, Portland Island, Long Point, Wairoa, Tangoio, Ahuriri, and Cape Kidnappers, but did not land, although (as he says) they were about to do so (near our Petane). After another unhappy affair near Cape Kidnappers, Cook sailed south as far as Cape Turnagain, and then returning north anchored on the 20th in a small bay north of Tolago Bay (probably Anaura), where they first watered in New Zealand. In the evening of this day Cook being pleased with the people again went on shore, and remained here and at the adjoining bay of Tolago (to which he had removed on the 22nd) until the 30th, when he sailed to the north. During nearly the whole of this time Cook and his companions

were mostly on shore, not at all annoyed by the Maoris, who (as he says) "behaved very civilly, showing us everything that we expressed a desire to see;" and enjoying themselves greatly in rambling about, going into the woods, seeing what was to be seen, and in making extensive botanical and other collections, having also with him on shore nearly the whole strength of his ship, including the chief officers, the scientific gentlemen, and the marines. He says (after leaving Tegadoo, or Anaura bay):—"In the afternoon of the 23rd, as soon as the ship was moored, I went on shore to examine the watering-place, accompanied by Mr. Banks and Dr. Solander; the boat landed in the cove without the least surf; the water was excellent and conveniently situated; there was plenty of wood close to high-water mark; and the disposition of the people was in every respect such as we could wish. * * * On the 24th, early in the morning, I sent Lieutenant Gore on shore to superintend the cutting of wood and filling of water, with a sufficient number of men for both purposes, and all the marines as a guard. After breakfast I went on shore myself, and continued there the whole day. Mr. Banks and Dr. Solander also went on shore to gather plants, and in their walks saw several things worthy of notice," etc., etc.

And here I would remark (1), that we know, from Cook's own words, the high expectations all on board of his ship had on their first seeing this new land; which, no doubt, was greatly increased during their slow approach of from two to three days to their first anchorage: Cook says, "The land became the subject of much eager conversation; but the general opinion seemed to be that we had found the *Terra australis incognita.*" (2). That at this time (as a matter of course) Captain Cook did not know how far the land he had discovered extended to the north, neither was he sure (after the experience he had had of its natives and of its coast) that he should ever land again; or, if he should, that he could possibly have a better opportunity than he had here, during his ten days' stay at Anaura and Tôlago Bays. Here then, *if he had not already done so*, would have been the place and the fitting opportunity for him to have taken possession of his newly-discovered country.

Leaving Tolago Bay on the 30th October, Captain Cook coasted north until the 4th November, when he anchored at Mercury Bay. Here he remained from ten to eleven days, spending, with his party, much of their time on shore very agreeably. On their leaving the bay, on the 15th, they acted in the manner already quoted and described. So that, if this was really the *first* time of his taking formal possession of the country, he had been no less than thirty-eight days in the New Zealand waters, of which about twenty-four days were spent on land in various places on the east coast; and yet, though nothing hindered, and delay in such matters (as we have seen) was not in keeping with Cook's

custom or temper, such an important event was unaccountably delayed for a very long period; and note, further, that in his now leaving Mercury Bay, he was not about to leave the country.

I come now to the positive part of my argument, viz:—

(Third). What has also been published respecting Cook's taking possession of New Zealand by a fellow-voyager and witness of the transaction.

Sir Joseph Banks took with him an experienced draughtsman, named Sydney Parkinson. (Of this young gentleman, who was a member of the Society of Friends, I have something more to say in a brief memoir.) He kept a journal of the proceedings and of the main incidents of the voyage. Unfortunately he died at sea, after leaving Batavia, on the voyage home of the ship, much lamented by all on board. His journal, however, was published in London by his brother, in the same year as the larger work of Cook's First Voyage (1773), and in it Sydney Parkinson, speaking of their landing, etc., in Poverty Bay, says:—"Early on the morning of the 10th, the long-boat, pinnace, and yawl went on shore again, and landed near the river where they had been the night before, and attempted to find a watering-place. Several of the natives came towards them, and, with much entreating, we prevailed on some of them to cross the river, to whom we gave several things which they carried back to their companions on the other side of the river, who seemed to be highly pleased with them, and testified their joy by a war-dance. Appearing to be so pacifically disposed, our company went over to them and were received in a friendly manner. Some of the natives were armed with lances, and others with a kind of stone-truncheon; through the handle of it was a string which they twisted round the hand that held it when they attempted to strike at any person. We would have purchased some of their weapons, but could not prevail on them to part with them on any terms. One of them, however, watched an opportunity and snatched a hanger from us; our people resented the affront by firing upon them and killed three of them on the spot; but the rest, to our surprise, did not appear to be intimidated at the sight of their expiring countrymen, who lay weltering in their blood; nor did they seem to breathe any revenge upon the occasion; attempting only to wrest the hanger out of the man's hand that had been shot, and to take the weapons that belonged to their other two deceased comrades, which having effected, they quietly departed. *After having taken possession of the country in form for the King*, our company embarked and went round the bay in search of water again, and to apprehend, if possible, some of the natives, to gain farther information of them respecting the island. They had not gone far before they saw a canoe; gave chase to it; and when they came up with it, the

crew threw stones at them, and were very daring and insolent. Our people had recourse to their arms: the captain, Dr. Solander, and Mr. Banks fired at them and killed and wounded several of them. The natives fought very desperately with their paddles, but were soon overpowered; their canoe was taken, three of them made prisoners and brought on board the ship, and the rest were suffered to escape."*

In connection with this I just copy a few sentences from Cook's voyage where, in speaking of this landing, Cook (or his editor, Dr. Hawkesworth) says:—"In the morning (October 9th) we saw several of the natives where they had been seen the night before. As I was desirous to establish an intercourse with them I ordered three boats to be manned with seamen and marines, and proceeded towards the shore accompanied by Mr. Banks, Dr. Solander, the other gentlemen, and Tupia. On the marines being landed they marched with a jack carried before them to a little bank about fifty yards from the water-side; here they were drawn up, and I again advanced with Mr. Banks and Dr. Solander; Tupia, Mr. Green, and Mr. Monkhouse being with us."

Here, then, we have from a qualified and unexceptionable eye-witness, in plain and positive language, that on this day and in this place the newly-discovered country was formally taken possession of for the King; and we also see from Captain Cook's statement that there were on shore on that occasion the marines and the English colours and the gentlemen of the ship, with a fine long summer's day before them,—"the foe, too, having retreated."

I may also mention that Parkinson's entry in his journal of their taking formal possession of Ulietea, (already quoted from Cook), is made in a similar manner; he says,—"The captain went on shore and took possession of the island for the King; he saw but few inhabitants and scarce any of distinguished rank among them."

And it should not be forgotten: (1). That Sydney Parkinson was a very moral, truthful, young man, one not likely to have entered anything wrong in his journal; indeed all his entries exhibit carefulness. (2). That Sydney Parkinson died at sea on their voyage to England, so that he could not have purposely altered his journal; and further, (3), that as his journal was published by his brother in London in the same year in which Cook's first voyage appeared, it cannot be reasonably said or supposed that any addition or alteration thereto was made by the publishers, who were, of course, as utterly ignorant of the materials Dr. Hawkesworth had at command as they were of New Zealand itself! Besides, his brother, the editor, says in his preface,—"I shall leave the works of my brother to speak his talents,†

* Parkinson's Journal, pp. 87, 88.

† The journal is profusely illustrated from his drawings.

thinking I have paid a proper respect to his memory, though it should be said of his journal (which has been faithfully transcribed)—that its only ornament is truth, and its best recommendation, characteristic of himself, its genuine simplicity."

I cannot bring myself to believe that Capt. Cook omitted the taking the formal possession of the country on that occasion; seeing, too, that he had with him the marines, and the flag, and the gentlemen of the ship—that the coast was clear of the enemy, who had, as he says, "slowly retreated to the interior after crossing the river, carrying their dead and wounded with them"—that a heavy surf was then settling the shore (which, indeed, prevented their landing again anywhere on that eventful day), and that this was now the second day of their being on shore in the newly-discovered country.

And here I may mention that, just twenty years after, Lieut. Broughton, in H.M. Brig "Chatham," took possession of the Chatham Islands, in these seas, under somewhat similar circumstances. Lieut. Broughton was under Capt. Vancouver, who in the "Discovery" commanded that expedition, and who had been (as he says in his voyages) four times to New Zealand with Capt. Cook; and as Lieut. Broughton received his directions from Capt. Vancouver, no doubt they were like those formerly issued by his old commander Capt. Cook. Lieut. Broughton says of his first landing at those islands:—"Accompanied by Mr. Johnston the master and one of the mates we proceeded towards the shore in the cutter. * * * As the natives approached they made much noise * * * and seemed very anxious to receive us on shore; but as all our intreaties were ineffectual in obtaining anything in return for our presents, perceiving many of them to be armed with long spears, and the situation being unfavourable to us in case they should be disposed to treat us with hostility, we did not think it prudent to venture among them. * * * But having again reached the shore without any interruption, we displayed the Union flag, turned a turf, and took possession of the island, which I named Chatham Island (in honour of the Earl of Chatham), in the name of His Majesty King George the Third, under the presumption of our being the first discoverers."*

On the whole, I conclude that Sydney Parkinson is right; and that the act of taking formal possession of the country of New Zealand in the name of the King was done on that particular day, viz., the 10th or 9th of October, 1769, at Poverty Bay, and not on the 15th of November following, at Mercury Bay.

* Vancouver's Voyages, Vol. I., p. 86.

At the same time I am aware of the difference in dates as to the day of the month between Parkinson and Captain Cook as edited by Dr. Hawkesworth. Sydney Parkinson gives the 10th of October as the day on which those events occurred; which, in Cook's Voyage, is as clearly said to have happened on the 9th. And this difference of a day extends throughout nearly the whole of that month in both journals, save that on the 1st they both agree, and then again on the 30th they do so. So that, from the 2nd to the 29th of October inclusive, all the entries of occurrences in Parkinson's Journal (and they are almost daily made) are one day in advance of the corresponding ones in Captain Cook's Voyage. And what is still more strange is the further record of this difference as to date in their respective maps of New Zealand. In both maps the ship's track all around New Zealand is given; in Parkinson's it is engraved,—"*Made the coast October 5th, 1769*;"—in Cook's, "*Made the coast October 6th, 1769.*" I have endeavoured, by closely comparing the two accounts, to find out where the error is, or how it occurred, but I have failed to do so. On the one hand, in Parkinson's Journal, we have almost daily entries, generally made in separate paragraphs; while, on the other hand, in Cook's Voyage, we have the day of the week given as well as the day of the month,—although in a few places several days are thrown together in a single paragraph; and we must not lose sight of this, that the editor, Dr. Hawkesworth, made use of several journals in compiling his narrative.

And now I will offer a few remarks on what may possibly be the real meaning of the ceremony of taking possession at Mercury Bay. First, however, for clearness, again quoting that paragraph:—"Before we left the bay we cut upon one of the trees near the watering-place the ship's name and that of the commander, with the date of the year and the month when we were there, and after displaying the English colours I took a formal possession of it in the name of His Britannic Majesty King George the Third."

May "it" not mean "the bay?" that being the proper antecedent to the pronoun "it;" the *country* is not mentioned. Moreover, it should be noted that Cook does not say in speaking of "the date" which he caused to be cut that such was the date of his discovery of the country; but, on the contrary, that of "the month" of their being "there"—at that bay and watering-place, which we know was not the month in which he discovered the land. Curiously enough Parkinson makes no allusion whatever to this ceremony at Mercury Bay in his journal, although he says a good deal about the place and people, etc., etc.

Further, Capt. Cook may have had several reasons for so doing; two prominent ones I will mention:—1. Capt. Cook observes that he heard

continually (both when on shore at the various places where he had landed, and from the very many canoes, which, during his coasting voyage S. and N., came alongside) of a great chief or king named Teratu; this he mentions several times, and seems to have been in great expectation of meeting with him. When nearing Mercury Bay (having passed the island which he named the Mayor and the Court of Aldermen), he says:—"As far as we had yet coasted this country from Cape Turnagain, the people acknowledged one chief whom they called *Teratu*." And again, "It is much to be regretted that we were obliged to leave this country without knowing anything of Teratu but his name. As an Indian monarch, his territory is certainly extensive: he was acknowledged from Cape Kidnappers to the northward and westward as far as the Bay of Plenty, a length of coast upwards of 80 leagues, and we do not yet know how much farther westward his dominions may extend. Possibly the fortified towns which we saw in the Bay of Plenty may be his barrier; especially as at Mercury Bay he was not acknowledged, nor indeed any other single chief."

But after landing in Mercury Bay and obtaining friendly intercourse with the natives residing there, Cook says:—"It was also discovered that the natives of Mercury Bay acknowledged neither Teratu nor any other person as their king; as in this particular they differed from all the people that we had seen upon other parts of the coast, we thought it possible that they might be a set of outlaws in a state of rebellion against Teratu, and in that case they might have no settled habitations or cultivated land in any part of the country."

Hence he might have done it through supposing he was now in another king's territory; but I do not believe this. At the same time it should not be forgotten that Captain Cook came direct to New Zealand from the Society Isles and other Polynesian islands where he had seen all the inhabitants living under kings; of whose immense power over their people he had also seen a great deal.

2. One of Captain Cook's principal instructions from the British Government was,—to observe the transit of Venus in the South Seas; and for this purpose he was accompanied by Mr. Green, the astronomer. This was a matter eagerly looked forward to by all the leading scientific men of Europe; and Captain Cook in carrying it out was highly fortunate. So again at Mercury Bay, where he stayed some days to observe the transit of Mercury; here he was again "in luck," as the sailors say;—he was in a good situation, with plenty of leisure and skilled assistants, free from annoyance from natives, and, as before, favoured with delightfully fine weather, for we read, "not a cloud intervened during the whole transit!" On the day of their leaving the place he says, "to the bay which we had now

left I gave the name of Mercury Bay, on account of the observation which we had made there of the transit of the planet over the sun." What then could have been a more appropriate termination at such a time than to cut the date of their successful scientific achievement "to be left as a memorial of our having visited this place,"* (to use his own words recorded on a subsequent occasion), accompanied with a display of the English colours, and to take a formal possession of the bay (or territory) in which they had performed that duty in the name of the King?

At all events we find him doing something very similar some six or seven months later when at Botany Bay. He says:—"During my stay in this harbour I caused the English colours to be displayed on shore every day, and the ship's name and the date of the year to be inscribed upon one of the trees near the watering-place."† In this instance, the taking of formal possession of the whole country or island as being the first discoverer, had nothing to do with it; as New Holland (as it was then called) had been discovered and visited long before Captain Cook's time.

Lastly, and in conclusion, I will say, that if what I have herein advanced is considered to be of the least moment towards the defining of an interesting point in our history, it will not, it cannot end here: and that is just what I wanted. Captain Cook's log-books and ship's papers are, no doubt, still in existence, and in safe keeping. By an accurate and close examination of them—particularly of his landing at Poverty Bay—the whole matter will, I have little doubt, be fully determined and for ever settled.

And if it should be asked why it was that I never brought this matter forward before, seeing it is one of public or of national importance, I think I can also satisfactorily answer that, but I reserve my reply.

Art. IX.—*Manibus Parkinsonibus sacrum. A brief Memoir of the First Artist who visited New Zealand: together with several little-known Items of Interest extracted from his Journal.* By W. Colenso, F.L.S.

[Read before the Hawke Bay Philosophical Institute, 13th August, 1877.]

Our Institute having been "founded for the advancement of science, *literature*, and *art*," it cannot be considered amiss to bring to your notice the first artist who visited our shores.

I confess I like to do something of this kind. To commemorate those dear fellow-labourers, those true disciples of nature, who preceded us in this

* II., p. 400: (Jan. 30, 1770). † III., p. 506.

country, and who have gone before us! Especially when, as in the present case, the person is almost totally unknown to fame, through several adverse and wholly unforeseen circumstances having operated to rob him of his due; and yet, one who did much, very much, under many great and serious disadvantages, of which, experimentally, we now know but little.

Often indeed have I, when, 30–40 *(et ultra)* years ago, botanizing in the forests of New Zealand, thought on this young artist of whom I am about to write; when I have considered how greatly delighted he must have been when he first gathered and drew those flowers which then pleased me, and which I knew he and his botanical friends and companions had also seen; and further, that, of all the scores of New Zealand plants and flowers (which he had the privilege of first viewing as novelties with an intelligent and loving eye and heart, and so truthfully and beautifully delineating), not one has yet been selected to bear his honoured name! At such times, beautiful and appropriate lines from our English poets—Milton, Gray, and Wordsworth—would rush into my memory, as if evoked from the depths by some potent spell! Wordsworth truly and feelingly says (though many do not understand him)—

> "To me, the meanest flower that blows can give
> Thoughts that do often lie too deep for tears."

It is indeed remarkable (at least in contrast, and worthy of a passing remark), in looking over the names of the hundreds of plants discovered in New Zealand by its first scientific visitors, to find so few bearing the name of the finder or of any individual. Then, and for many years after, the disciples of Linnæus acted up to the Linnæan canons; but now, in our modern day, almost every other newly-discovered (or newly-named) plant or animal among us, is honoured or lowered with the name of its gatherer or lucky owner, or even with that of the child or patron of its describer or namer, no matter whether he or she is or is not a true lover and patron of science!

Dr. Hawkesworth, the editor of Cook's First Voyage, tells us in his introduction, that Mr. (afterwards Sir Joseph) Banks, in his equipping for a voyage to the South Seas with Captain Cook in the "Endeavour," was determined to spare no expense in the execution of his plan. He first engaged Dr. Solander, a Swede, and educated under Linnæus; and he also took with him two draughtsmen—one to delineate views of figures, the other to paint such subjects of natural history as might offer; together with a secretary and four servants, two of whom were negroes." The first-mentioned of these "two draughtsmen," a Mr. Buchan, died early, within a week after their arrival at Tahiti (their first port of call in the Pacific), deeply regretted by all on board; the other, the gentleman whose

duty it was to paint subjects of natural history, was Mr. Sydney Parkinson, the subject of this memoir, on whom (through the death of his colleague) the whole work of drawing, delineating, and painting now devolved.

Most, if not all, of us are conversant from boyhood with the many and varied figures in Cook's voyages; of tattooed chiefs and great personages in extraordinary dresses; of processions and dances; of canoes and implements; and of peculiar and romantic scenery; and these are still being continually republished in various sizes to suit many modern works. Many of these were executed by our Mr. Sydney Parkinson; but these are as nothing when compared with the hundreds of coloured drawings of plants faithfully and beautifully made by the same person, which, though unpublished, are still preserved in the Banksian collection in the British Museum. Dr. Hooker, when preparing his "Botany of New Zealand," examined those drawings, and says:—"For the earliest account of the plants of these islands we are indebted to two of the most illustrious botanists of their age, and to the voyages of the greatest of modern navigators; for the first and to this day the finest and best illustrated herbarium that has ever been made in the islands by individual exertions, is that of Sir Joseph Banks and Dr. Solander during Captain Cook's first voyage in 1769. Upwards of 360 species of plants were collected during the five months that were devoted to the exploration of these coasts, at various points between the Bay of Islands and Otago, including the shores of Cook Strait; and the results are admirable, whether we consider the excellence of the specimens, the judgment with which they were selected, the artistic drawings by which they are illustrated, and above all the accurate MS. descriptions and observations that accompany them. That the latter, which include a complete flora of New Zealand as far as then known, systematically arranged, illustrated by 200 copper-plate engravings, and all ready for the press, should have been withheld from publication by its illustrious authors, is (considering the circumstances under which it was prepared) a national loss, and to science a grievous one; since, had it been otherwise, the botany of New Zealand would have been better known fifty years ago than it now is. This herbarium and MS. form part of the Banksian collection, and are deposited in the British Museum. I feel that I cannot over-estimate the benefit which I have derived from these materials, and it is much to be regretted that they were not duly consulted by my predecessors. The names by which Dr. Solander designated the species have in most cases been replaced by others, often applied with far less judgment; and his descriptions have never been surpassed for fulness, terseness, and accuracy. The total number of drawings of New Zealand plants is about 212, of which 176 are engraved on copper, but the

engravings have never been published."* And I have good reasons for adding, that the number of drawings of plants and animals discovered by them in other places during that voyage would far exceed this.

Mr. John Edward Gray (late keeper of the Zoological collections in the British Museum) also bears testimony to Mr. Parkinson's abilities in his notes on the Fauna of New Zealand, published in Vol. II. of Dieffenbach's Travels in New Zealand. Mr. Gray says:—"Nothing was known of the natural productions of New Zealand until Captain Cook's first voyage, in which he was accompanied by Mr. (afterwards Sir Joseph) Banks, Dr. Solander, and Mr. Sydney Parkinson, an artist of considerable merit, who was employed by Sir Joseph Banks to draw the specimens of animals and plants which were discovered during the voyage. The drawings made by Sydney Parkinson, together with the manuscript notes of Dr. Solander, are with the Banksian collection of plants in the British Museum, and form part of the very extensive and magnificent collection of natural history drawings belonging to that institution."† To which I will merely add that those drawings are folio size.

Unfortunately this good, able, and active young man died at sea on their voyage home from the South Seas, in January, 1771, about a month after leaving Batavia. His published journal, which is profusely illustrated, contains, among other interesting drawings, a few which are not to be found in Cook's Voyage, one being the Tahitian lad Taiota, the hero of Cape Kidnappers; another that of a New Zealand chief bearing a style of tattooing which has long become extinct, and of which I only saw a few specimens some forty years ago; there are also views of scenery here on our east coast, and a portrait of himself. In his journal he gives the common and Latin names of nearly eighty plants of the Society Islands, with their descriptions and uses; occupying no less than fourteen large 4to. pages; and several copious vocabularies of the various languages which he had noticed during the voyage. Several of his entries made throughout the voyage are not to be found in Cook—that is, as published. A few of the most striking of these being but little known, I shall copy into this paper.

The Journal was published in London in the year 1773, in 4to., (same size as Cook's Voyages and in the same year), entitled, "A Journal of a Voyage to the South Seas, in His Majesty's ship the 'Endeavour,' faithfully transcribed from the papers of the late Sydney Parkinson, draughtsman to Joseph Banks, Esq., on his late expedition with Dr. Solander round the world." His brother, Stanfield Parkinson, was the editor, who it appears had very great difficulty in obtaining it, with other things, from

* "Flora N.Z.," Vol. I., pp. 2, 3.

† Dieffenbach's Travels in N.Z., Vol. II., p. 177. Hooker's Hand-book of N.Z. Flora, p. 9.

Mr. Banks, as is fully shown in a long preface of twenty closely-printed pages containing several letters respecting the whole transaction. Subsequently, Mr. Banks and Dr. Hawkesworth also attempted to stop even its publication by an injunction from the Court of Chancery, which, however, was finally dissolved and the work published. From its extreme scarceness (I having sought more than ten years for a copy before I could get one), and from its not having been quoted or referred to by any modern writer on New Zealand—(not even mentioned by Dr. Thomson, in his long list of everything on New Zealand—good, bad, and indifferent)—I have always been of opinion that it was in a great measure sought to be suppressed by buying it up. Stanfield Parkinson complains bitterly and feelingly of the conduct of both Mr. Banks and Dr. Hawkesworth in the whole affair; among other things, pointing out their meanness and invidiousness in not allowing his deceased brother's name as draughtsman to be inserted in the plates to Cook's Voyage, while that "of the engraver is pompously displayed." From the preface already mentioned I extract the following:—

"Sydney Parkinson was the younger son of the late Joel Parkinson of Edinburgh, one of the people commonly called Quakers. Sydney, taking a great delight in drawing flowers, fruits, and other objects of natural history, became soon so proficient in that style of painting as to attract the notice of the most celebrated botanists and connoisseurs in that study. In consequence of this he was, some time after his arrival in London, recommended to Joseph Banks, Esq., whose very numerous collection of numerous and highly-finished drawings of that kind, executed by Sydney Parkinson, is a sufficient testimony both of his talents and application.

"His recommendation being so effectually confirmed by these proofs of ingenuity and industry, Joseph Banks made him the proposal of going in the capacity of botanical draughtsman on the then intended voyage to the South Seas. An insatiable curiosity for such researches prevailed over every consideration of danger that reasonably suggested itself, as the necessary attendant of so long, so perilous, and, to my poor brother, so fatal a voyage! He accordingly accepted Joseph Banks's offer, though by no means an alluring one, if either views of profit, or perhaps even prudence, had influenced his determination. His appointment, for executing drawings of botanical subjects and curious objects of natural history, was settled at £80 per annum. In this capacity, and under this moderate encouragement, Sydney Parkinson undertook to accompany Joseph Banks to the South Seas; making his will before his departure, in which he bequeathed the salary which might be due to him at the time of his decease, to his sister Britannia, and appointed me his residuary legatee.

"I have heard many of the surviving companions of this amiable young

man dwell with pleasure on the relation of his singular simplicity of conduct, his sincere regard for truth, his ardent thirst after knowledge, his indefatigable industry to obtain it, and his generous disposition in freely communicating with the most friendly participation to others, that information which none but himself could have obtained. That this is more than probable will appear, on comparing the different manner in which Sydney and his associates passed their time in the most interesting situations. While many others, for want of a more innocent curiosity or amusement, were indulging themselves in sensual gratifications,—we find him gratifying no other passion than that of a laudable curiosity, which enabled him inoffensively to employ his time and escape those snares into which the vicious appetites of some others betrayed them. It doth equal honour to his ingenuousness and ingenuity, to find him protected by his own innocence, securely exercising his pleasing art amidst a savage, ignorant, and hostile people; engaging their attention by the powers of his pencil, disarming them of their native ferocity, and rendering them even serviceable to the great end of the voyage in cheerfully furnishing him with the choicest productions of the soil and climate, which neither force or stratagem might otherwise have procured.

"By such honest arts and mild demeanour he soon acquired the confidence of the inhabitants of most places at which the voyagers went on shore; obtaining thus, as I am well-informed, with remarkable facility, the knowledge of many words in various languages hitherto little, if at all, known in Europe.

"These paved the way also to his success in acquiring a choice and rare collection of curiosities, consisting of garments, domestic utensils, rural implements, instruments of war, uncommon shells, and other natural curiosities of considerable value—of so much value, indeed, as even to seduce men of reputed sense, fortune, and character, to attempt, by means unworthy of themselves, to deprive me of what, after the loss sustained in the death of so deserving a brother, one would think none ought to envy me the gain.

* * * * * * * *

"Of these curiosities, the shells alone Dr. John Fothergill (a common friend of my late brother and Joseph Banks) had valued at £200; yet neither the shells, nor anything else, hath Joseph Banks to this day returned me. The reasons he gives for the detention are—that I have used him ill; that he hath given me a valuable consideration for them; and, in short, that he will keep them. Of this pretended valuable consideration I am now to speak. On the readiness I showed to oblige Joseph Banks with such of the shells as he might not have in his collection, Dr. Fothergill informed me

that Joseph Banks told him he had much reason to be satisfied with the services of Sydney Parkinson, and the cheerfulness with which he executed other drawings than those of his own department; supplying, in fact, the loss of Joseph Banks's other draughtsman who died in the beginning of the voyage. On this account Joseph Banks was pleased to say, it had been his constant intention to make Sydney Parkinson a very handsome present had he lived to return to England. His intention was now to take place, therefore, towards his brother and sister, to whom he would make the like present in consideration of such extra service, or, as Joseph Banks himself expressed it, a *douceur* to the family for the loss sustained in the death of so valuable a relation. There being due to the deceased upwards of £150 salary, the sole property of my sister Britannia, and Joseph Banks choosing to keep some of the effects bequeathed to me as before mentioned, it was agreed between Dr. Fothergill and Joseph Banks that the latter should make up the sum of £500, to be paid into the hands of me and my sister.

* * * * * * * *

"It was in vain I expected Joseph Banks would keep his word with me. He sent me back, indeed, my brother's drawers and boxes quite empty, without the civility of even a message by the bearers. I complained, of course, to Dr. Fothergill, who afterwards said he could obtain no satisfaction for me. After several fruitless attempts to obtain it myself I wrote to Joseph Banks acquainting him that if he did not immediately return the curiosities I would inform the world of the whole transaction between us, and endeavour to indemnify myself by publishing also my brother's journal.

"As I made no secret of my design, and was known to have employed the proper artists to execute it, I was now solicited and entreated by Joseph Banks's friends to desist; Dr. Fothergill, in particular, offered me at different times, several sums of money to drop my intended publication, notwithstanding he knew Joseph Banks still detained my curiosities contrary to agreement, and refused to come to any accommodation.

"To delay this design and, if possible, suppress my book, which was almost ready to appear, Dr. Hawkesworth, whose compilation was not so forward, filed a bill in chancery against me, setting forth that I had invaded his property by printing manuscripts and engraving designs which I sold to Joseph Banks, and which Joseph Banks afterwards sold to him. On this application an injunction was granted by the Court of Chancery to stop the printing and publishing of my work. Put thus to the trouble and expense of defending a suit in chancery, and the publication of my work being delayed when just ready to appear, I had yet no remedy but that of putting in a full answer to the bill and praying a dissolution of the injunction. This I at length obtained, the reasons for continuing the injunction not appearing

satisfactory to the Court. * * Indeed, the whole purpose appears to be litigious, and calculated to answer no other end than to delay my publication till he should get the start of me and publish his own, and this end, to my great damage and loss, it hath answered."

In conclusion, the editor says:—"Having thus given a simple, unvarnished narrative of the causes of the delay of this publication, I submit its encouragement to the judgment and candour of the public. In respect to the comparative merits of Dr. Hawkesworth's book and mine, it is not for me to say anything. If I have justified myself in the eye of the impartial world for persisting in this publication, I shall leave the works of my brother to speak his talents, thinking I have paid a proper respect to his memory, though it should be said of his journal that its only ornament is truth, and its best recommendation, characteristic of himself, its genuine simplicity."

In making a few extracts from Sydney Parkinson's Journal, I have confined myself to such as are not particularly mentioned in Cook's Voyage; paying especial attention to those which refer to our own immediate sea of Hawke Bay and the east coast of the North Island. It is a notable fact (though, perhaps, little known) that though Capt. Cook visited New Zealand several times and spent many months altogether in the bays and harbours and on the coasts of this country, the only bay which he fully explored and sailed all round its shores was our Hawke Bay, and that on his first voyage when Sydney Parkinson was with him.

Their whole number in their little barque the "Endeavour," of 370 tons, was ninety-six. At Madeira they had the misfortune to lose their chief mate, Mr. Ware, by drowning, which is thus related:—"His death was occasioned by an unlucky accident which happened to him while he stood in the boat to see one of the anchors slipped. The buoy-rope happening to entangle one of his legs, he was drawn overboard and drowned before we could lend him any assistance. He was a very honest, worthy man, and one of our best seamen." And a similar misadventure happened at their next port-of-call, Rio, where, "in coming out of the harbour, Mr. Flowers, an experienced seaman, fell from the main shrouds into the sea and was drowned before we could reach him."

These circumstances and others like them are brought to your notice in this memoir, that you should know that the successful voyage of our illustrious navigator cost a great sacrifice of human life from among his own ship's company. This has, I think, been almost, if not altogether, overlooked by the public at large, in reading or in hearing of Cook's famous voyage! The halo that justly surrounds his imperishable name is so grand, so overpowering, that the loss of so many of his brave companions during

that first eventful voyage, is, as it were, lost sight of; and yet I question if there has been another voyage of modern times in which so many skilled and useful men died, and not through battle or storm or dangers.

At Rio our voyagers received harsh treatment from the Viceroy, who prohibited any person coming on shore from the ship. This is fully related by Cook. Our artist says: "We were displeased in receiving this intelligence; Mr. Banks and Dr. Solander appeared much chagrined at their disappointment, but notwithstanding all the Viceroy's precautions we determined to gratify our curiosity in some measure, and having obtained a sufficient knowledge of the river and the harbour by the surveys we had made of the country, we frequently, unknown to the sentinel, stole out of the cabin window at midnight, letting ourselves down into a boat by a rope, and driving away with the tide until we were out of hearing, we then rowed to some unfrequented part of the shore where we landed and made excursions up into the country, though not so far as we could have wished to have done. The morning after we went on shore my eyes were feasted with the pleasing prospects that opened to my view on every hand. I soon discovered a hedge in which were many very curious plants in bloom, and all of them quite new to me. There were so many that I even loaded myself with them. We found also many curious plants in the salading that was sent off to us." From Rio he wrote to his brother saying he had "finished 100 drawings on various subjects and taken sketches of many more." He narrates that terrible night of Mr. Banks and Dr. Solander and their party in the snows on the mountains of Terra del Fuego, in which two men of the party were frozen to death, (which we have at full length and well told in Cook), adding,—"The dog that had been with them all night had survived them; he was found sitting close by his master's corpse, and seemed reluctant to leave it, but at length the dog forsook it, and went back to the company and to the ship." His remarks, in passing the straits of Le Maine and round Cape Horn, are worthy of notice:—

"The land on both sides, particularly Staten-land, affords a most dismal prospect, being made up chiefly of barren rocks and tremendous precipices, covered with snow and uninhabited, forming one of those natural views which human nature can scarcely behold without shuddering. How amazingly diversified are the works of the Deity within the narrow limits of this globe we inhabit, which, compared with the vast aggregate of systems that compose the universe, appears but a dark speck in the creation! A curiosity, perhaps equal to Solomon's, though accompanied with less wisdom than was possessed by the Royal Philosopher, induced some of us to quit our native land, to investigate the heavenly bodies minutely in distant regions, as well as to trace the signatures of the Supreme Power and

Intelligence throughout several species of animals, and different genera of plants in the vegetable system,—'from the cedar that is in Lebanon, even unto the hyssop that springeth out of the wall;' and the more we investigate the more we ought to admire the power, wisdom, and goodness of the Great Superintendent of the universe; which attributes are amply displayed throughout all his works; the smallest object seen through the microscope declares its origin to be divine, as well as those larger ones which the unassisted eye is capable of contemplating: but to proceed. We saw Cape Horn at first at about five leagues distance, which, contrary to our expectations, we doubled with as little danger as the North Foreland on the Kentish coast; the heavens were fair, the wind temperate, the weather pleasant, and being within one mile of the shore, we had a more distinct view of this coast than perhaps any former voyagers have had on this ocean."

His mention of their landing at Tahiti, and what soon followed, is entertaining:—"In the morning we went ashore and pitched the marquee; Mr. Banks, the captain, and myself took a walk in the woods, and were afterwards joined by Mr. Hicks (the first lieutenant) and Mr. Green (the astronomer). While we were walking and enjoying the rural scene, we heard the report of some fire-arms, and presently saw the natives fleeing into the woods like frighted fawns, carrying with them their little movables. Alarmed at this unexpected event, we immediately quitted the wood and made to the side of the river, where we saw several of our men, who had been left to guard the tent, pursuing the natives, who were terrified to the last degree; some of them skulked behind the bushes, and others leaped into the river. Hearing the shot rattle amongst the branches of the trees over my head, I thought it not safe to continue there any longer, and fled to the tent, where I soon learned the cause of the catastrophe. A sentinel being off his guard, one of the natives snatched a musket out of his hand, which occasioned the fray. A boy, a midshipman, was the commanding officer, and giving orders to fire, they obeyed with the greatest glee imaginable, as if they had been shooting at wild ducks, killed one stout man, and wounded many others. What a pity that such brutality should be exercised by civilized people upon unarmed, ignorant Indians! When Mr. Banks heard of the affair, he was highly displeased, saying, 'If we quarrelled with those Indians we should not agree with angels;' and he did all he could to accommodate the difference, going across the river, and, through the mediation of an old man, prevailed on many of the natives to come over to us, bearing plantain trees (which is a signal of peace amongst them), and, clapping their hands to their breasts, cried 'Tyau!' which signifies friendship. They sat down by us, sent for cocoa-nuts, and we drank the milk with them. They were very social, more so than could have

been expected, considering what they had suffered in the late skirmish! Have we not reason to conclude that their dispositions are very flexible, and that resentment with them is a short-lived passion?"

On their voyage south from the islands we have these entries:—"August 27th. We killed a dog and dressed him, which we brought on the 8th from Ulietea (Raiatea); he was excessively fat, although he had eaten nothing while he had been on board. On the evening of the next day, 28th, John Raden, the boatswain's mate, died. His death was occasioned by drinking too freely of rum the night before.—September 29th. Saw several parcels of sea-weed, and a land-bird that flew like a plover; with a great number of large white albatrosses with the tips of their wings black. We sounded and found no bottom with 120 fathoms of line. The captain apprehended that we were near land, and promised one gallon of rum to the man who should first discover it by day, and two if he discovered it by night; also, that part of the coast of the said land should be named after him. On the 1st of October the weather was fair but very cold, and almost calm. We saw a seal asleep upon the surface of the water, which had, at first, the appearance of a log of wood; we put the ship about to take it up, but it waked and dived out of sight. The master was sent in quest of a current but could find none; we having gone ten leagues farther to the north than what appeared in the log account. Though we had been so long out at sea in a distant part of the world, we had a roasted leg of mutton and French beans for dinner, and the fare of Old England afforded us a grateful repast. On the 2nd the sea was as smooth as the Thames. Mr. Banks went out in a little boat, and diverted himself in shooting of shearwaters; he also shot one white albatros that measured 10·7 feet; the water looked as green as it does in the Channel. On the 4th a great shoal of bottle-nosed porpoises swam alongside of the ship, with a great number of other porpoises having sharp white snouts, and their sides and bellies of the same colour. On the 5th we had light breezes from the N.E. and pleasant weather; about two o'clock in the afternoon, one of our people, Nicholas Young, the surgeon's boy, descried a point of land of New Zealand from the starboard bow, at about nine leagues distance, bearing W. and by N. We bore up to it, and at sunset we had a good view of it. The land was high, and it appeared like an island. We regaled ourselves in the evening upon the occasion; the land was called 'Young Nick's Head,' and the boy received his reward. The sea on this coast was full of a small transparent animal, which, upon examination, we called *Beroe coarctata*. On the 8th we had light breezes and dead calms all day, and could not get in nearer the land than two or three leagues: but it appeared at this distance to be of considerable extent. We saw smoke

ascend from different parts, and thence concluded that it was inhabited. On the 9th, early in the morning, the wind being favourable, we stood in nearer land, where it seemed to open and form a deep bay; but on approaching it we discovered low land, and it was much shallower than we expected. Upon entering we had regular soundings all the way, from twenty-six to six fathoms, and cast anchor on the east side in ten fathoms water about two or three miles from the shore, over against the land on the right where there was the appearance of a river. * * * Having cast anchor, the pinnace, long-boat, and yawl were sent on shore with the marines. As soon as the people who were in the pinnace had passed a little way up into the country, while the long-boat went up the river to see for water, some of the natives, who had hid themselves among the bushes, made their appearance, having long wooden lances in their hands, which they held up in a threatening posture as if they intended to throw them at the boys in the yawl. The cockswain, who stayed in the pinnace, perceiving them, fired a musketoon over their heads, but that did not seem to intimidate them; he therefore fired a musket, and shot one of them through the heart, upon which they were much alarmed and retreated precipitately. The water in the river was found to be brackish, in which we were disappointed; but they shot some wild ducks of a very large size, and gathered a variety of curious plants in flower.

"Early on the morning of the 10th the long-boat, pinnace, and yawl went on shore again, landed near the river where they had been the night before, and attempted to find a watering-place. Several of the natives came toward them, and, with much entreating, we prevailed on some of them to cross the river, to whom we gave several things, which they carried back to their companions on the other side of the river, who seemed to be highly pleased with them and testified their joy by a war-dance. Appearing to be so pacifically disposed, our company went over to them and were received in a friendly manner. Some of the natives were armed with lances, and others with a kind of stone-bludgeon; through the handle of it was a string which they twisted round the hand that held it when they attempted to strike at any person. We would have purchased some of their weapons, but could not prevail on them to part with them on any terms. One of them, however, watched an opportunity and snatched a hanger from us; our people resented the affront by firing upon them and killed three of them on the spot; but the rest, to our surprise, did not appear to be intimidated at the sight of their expiring countrymen who lay weltering in their blood, nor did they seem to breathe any revenge upon the occasion; attempting only to wrest the hanger out of the man's hand that had been shot, and to take the weapons that belonged to their other two deceased

comrades, which having effected, they quietly departed. After having taken possession of the country in form for the King, our company embarked and went round the bay in search of water again, and to apprehend, if possible, some of the natives, to gain farther information of them respecting the island. They had not gone far before they saw a canoe, gave chase to it, and when they came up with it, the crew threw stones at them, and were very daring and insolent. Our people had recourse to their arms; the Captain, Dr. Solander, and Mr. Banks fired at them and killed and wounded several of them. The natives fought very desperately with their paddles, but were soon overpowered; their canoe was taken, three of them made prisoners and brought on board the ship, and the rest were suffered to escape. They were in person much like the natives of Otaheite, but were loud and rude in their address, and more unpolished than the Otaheitians. We were much surprised to find they spoke the Otaheitian language, though in a different dialect, speaking very guttural, having a kind of *hec* which some of the people of Ulietea have in their speech. Tupaea understood them very well, notwithstanding they made frequent use of the *g* and *k*, which the people of Otaheite do not. Their canoe was thirty feet long, made of planks sewed together, and had a lug-sail made of matting. * * * We found here a sort of long-pepper which tasted very much like mace; a *Fulica* or a bald-coot of a dark blue colour; and a blackbird, the flesh of which was an orange colour, and tasted like stewed shell-fish. A vast quantity of pumice-stone lies all along upon the shore* within the bay, which indicates that there is a volcano in this island. On the 12th, early in the morning, we weighed anchor and attempted to find some better anchoring-place, as this bay (which, from the few necessaries we could procure, we called Poverty Bay) was not well sheltered from a S.E. wind, which brings in a heavy sea. The natives called the bay Te Oneroa, and the point of land at the entrance on the east side they called Te Tua Motu.

On the 13th, in the afternoon, after we had doubled a small high island, which was called Portland Isle, (or according to the natives, Te Haure,) we got into a sort of large bay, and the night coming on we thought it best to drop anchor, designing, next morning, to make for a harbour in the corner of the bay, where there was the appearance of an inlet. * * * On the 14th we made for the inlet which we saw the night before, and on coming up to it found that it was not sheltered, having only some low land at the bottom of it. Ten canoes filled with people chased us, but our ship sailing too fast for them they were obliged to give over the pursuit. We sailed round most part of the bay without finding any opening, and the soundings all along the shore were very regular. The country appeared more fertile

* This does not appear in Cook.

hereabout, and well covered with wood, the sea-shore making in clayey cliffs, upon which the surf broke very high. This bay was called Hawke's Bay. In the afternoon a canoe followed us with eighteen people in her armed with lances, but as they could not keep pace with us they gave up their expedition. In sailing along we could plainly distinguish land that was cultivated, parcelled out into square compartments, having some sorts of herbs growing upon them. On the 15th in the morning, we bent our course round a small peninsula which was joined to the mainland by a low isthmus, on which were many groves of tall straight trees, that looked as if they had been planted by art; and within side of it the water was quite smooth. We saw some very high ridges of hills streaked with snow, and when we had doubled the point of this peninsula, the low isthmus appeared again stretching a long way by the sea-side. The country looked very pleasant, having fine sloping hills which stretched out into beautiful green lawns, though not covered with wood, as other parts of the coast are. In the morning, while we were on the other side of the peninsula, nine canoes came off to us, in which were 160 of the natives; they behaved in a very irresolute manner, sometimes seeming as if they would attack us, then taking fright and retreating a little, one half paddling one way, and the other half paddling another, shaking their lances and bone bludgeons at us, talking very loud and blustering, lolling out their tongues, and making other signs of defiance. We did all we could to make them peaceable but to no purpose, for they seemed at length resolved to do us some mischief; coming alongside of the ship again and threatening us, we fired one of our guns loaded with grape-shot over their heads. They looked upon us for some time with astonishment, and then hastened away as fast as they could. By this time two other canoes came towards us, but stopped a little and held a conference with those that were returning, and then made up to us, leaving the rest at some distance, who seemed to wait their destiny. We made signs to them that we meant them no harm if they would behave peaceably, which they so well understood that they took all their weapons and put them into a canoe and sent it off while they came close to the ship. We threw them several kinds of things, but they were so timorous that they durst not venture on board, nor would they send anything to us. During this interview another canoe came up, threw a lance at the stern of the ship, and made off again. The lance fell into the water and sunk immediately. * * * Their canoes had from eighteen to twenty-two men in them, and were adorned with fine heads made out of a thick board, cut through like filagree work, in spirals of very curious workmanship. At the end of this was a head with two large eyes of mother-of-pearl, and a large heart-shaped tongue. This figure went round the bottom of the board, and had feet and

hands carved upon it very neatly and painted red; they had also high-peaked sterns, wrought in filagree and adorned with feathers, from the top of which depended two long streamers, made of feathers, which almost reached the water. Some of these canoes were between fifty and sixty feet long, and rowed with eighteen paddles by the like number of men, who look the same way they row, striking their paddles into the water with their points downward, at the same time bending their bodies forward, and as it were, driving the waves behind them. They gave us two *heivos* in their canoes which were very diverting. They beat time with their paddles, and ended all at once with the word *epaah*, at the same instant striking their paddles on the thwarts, all which afforded a truly comic act.

"On the 16th we had several fisher canoes come to us, and, after much persuasion, they gave us some fish for cloth and trinkets; but none of their fish was quite fresh, and some of it stank intolerably. They went away very well satisfied, and then a larger canoe, full of people, came up to us, having their faces shockingly besmeared with some paint. An old man, who sat in the stern, had on a garment of some beast's skin, with long hair, dark brown, and white border, which we would have purchased, but they were not willing to part with anything. When the captain threw them a piece of red baize for it, they paddled away immediately, held a conference with the fishers' boats, and then returned to the ship. We had laid a scheme to trepan them,* intending to have thrown a running bow-line about the head of the canoe, and to have hoisted her up to the anchor: but just as we had got her a-head for that purpose, they seized Tupaea's little boy, who was in the main-chains, and made off with him, which prevented the execution of our plan. We fired some muskets and great guns at them, and killed several of them.† The boy soon after disengaged himself from them, jumped into the sea, swam toward the ship, and we lowered a boat down and took him up, while the canoes made to land as fast as possible.

"In the evening we were over against a point of land, which, from the circumstance of stealing the boy, we called Cape Kidnappers. On doubling the cape we thought to have met with a snug bay, but were disappointed, the land tending away to a point southwards. Soon after we saw a small

* Not mentioned in Cook.

† I saw in 1843-45, at Waimarama, a village a few miles south of Cape Kidnappers, an aged native, who remembered this incident, and I also obtained from several natives, descendants from and near relatives to the sufferers on that occasion, their account of the affair, received from their forefathers; five, it appears, were killed, and several wounded. One of the poor fellows had received a ball in his knee joint, which could not be extracted, and which made him a helpless cripple during a long life.—(W. C., Journal, MS.)

island, which, from its desolate appearance, we called Bare Island. On the 17th we sailed along the coast, near as far as 41°, but not meeting with any convenient harbour to anchor in, the land lying north and south, when we came abreast of a round bluff cape, we turned back, being apprehensive that we should want water if we proceeded farther to the southward. We saw several villages, and in the night some fires burning upon the land. The coast appeared more barren than any we had seen before. There was clear ground and good anchorage upon the coast two or three miles from the shore, and from eight to twenty fathoms water. This cape we named Cape Turnagain.

"On the 19th, in the afternoon, we were off Hawke's Bay, which we could not enter, the wind being foul. A canoe came to us with five people in it, who seemed to place great confidence in us. They came on board, and said they would stay all night. The man who seemed to be the chief had a new garment, made of the white silky flax, which was very strong and thick, with a beautiful border of black, red, and white round it.

"On the 20th, early in the morning, having a fine breeze, we made Table Cape, passed Poverty Bay, and came to a remarkable point of land, being a flat, perpendicular, triangular-shaped rock, behind which there appeared to be a harbour, but on opening it we found none. This point we called Gable-end Foreland. The country is full of wood, and looks very pleasant in this part; but towards night we saw some land that appeared very broken and dreary, formed into a number of points, over which we could see the back land.

"On the 21st we anchored in a very indifferent harbour, in eight and a-half fathoms water, about one mile and a-half from the shore, having an island on the left hand, which somewhat sheltered us. Many canoes came off to us, and two old men of their chiefs came on board. These people seemed very peaceably inclined, and were willing to trade with us for several trifles which they had brought with them. We saw many houses, and several tracts of land, partly hedged in and cultivated, which formed an agreeable view from the harbour, called by the natives Te Karu. Some of our boats went ashore for water, and found a rivulet, where they filled their casks, and returned to the ship unmolested by the inhabitants, many of whom they saw near the rivulet.

"On the 22nd, in the morning, the boats went on shore again for wood and water; and a short time after, Mr. Banks and some others followed them; and while they were absent the natives came on board and trafficked with us, having brought some parcels of kumera and exchanged them with us for Otaheite cloth, which is a scarce commodity among them. They were very cunning in their traffic, and made much of low artifice. One of them

had an axe made of the before-mentioned greenstone, which he would not part with for anything we offered him. Several of them were very curiously tattooed. The natives, both on board and on shore, behaved with great civility, and at night they began to *heivo* and dance in their manner, which was very uncouth. Nothing could be more droll than to see old men with grey beards assuming every antic posture imaginable, rolling their eyes about, lolling out their tongues, and, in short, working themselves up to a sort of phrenzy.

"The surf running high, the men who went on shore found great difficulty in getting the water into the long-boat, and in coming off the boat was swamped. We therefore enquired of the natives for a more convenient watering-place, and they pointed to a bay bearing S.W. by W. On receiving this information we weighed anchor, but the wind being against us we stood off and on till the next morning, the 23rd, and then bore away to leeward, and looked into the bay which we had passed before. About noon we dropped anchor, and one of our boats went into a little cove where there was smooth landing and fresh water, and we moored the ship about a mile and a-half from the shore. This bay is called by the natives 'Tolago,' and is very open, being exposed to all the violence of the east wind. Several canoes came alongside of the ship, of whom we got some fish, kumeras or sweet potatoes, and several other things; but the natives were indifferent about most of the things we offered them, except white cloth and glasses which suited their fancy, so that we found it difficult to trade with them. They had some greenstone axes and earrings, but they would not part with them on any terms; and as to their kumeras they set great value upon them.

"The country about the bay is agreeable beyond description, and with proper cultivation, might be rendered a kind of second Paradise. The hills are covered with beautiful flowering shrubs, intermingled with a great number of tall and stately palms, which fill the air with a most grateful fragrant perfume. We saw the tree which produces the cabbage, which ate well boiled. We also found some trees yielded a fine transparent gum, and between the hills we discovered some fruitful valleys that are adapted either to cultivation or pasturage. The country abounds with different kinds of herbage fit for food. Our botanists were agreeably employed in investigating the trees and plants of the country. Within land there were many scandent ferns and parasitic plants, and on the sea-shore *Salicornias*, *Mesembryanthemum*, and others. The plant of which they make their cloth is a sort of *Hemerocallis*, and the leaves yield a very strong and glossy flax, of which their garments and ropes are made. Adjoining their houses are plantations of kumera and taro. These grounds are cultivated with great care and kept clean and neat.

"The natives behaved very civil to us; they are, in general, lean and tall yet well-shaped, have faces like Europeans, and, in general, the aquiline nose, with dark-coloured eyes, black hair which is tied up on the crown of the head, and beards of a middling length. * * Their cloth is white and as glossy as silk, worked by hands, and wrought as even as if it had been done in a loom, and is chiefly worn by the men though it is made by the women, who also carry burdens and do all the drudgery. Many of the women that we saw had very good features, and not the savage countenance one might expect. The men have their hair tied up, but the women's hangs down, nor do they wear feathers in it like the men, but adorn it with leaves. They seem to be proud of their sex, and expect you should give them everything they desire because they are women, but they take great care of themselves, and are exceedingly modest, in this respect being very different from the women we saw in the islands.

"The men have a particular taste for carving; their boats, paddles, boards to put on their houses, tops of walking-sticks, and even their boats' valens are carved in a variety of flourishes turnings and windings that are unbroken; but their favourite figure seems to be a volute or spiral which they vary many ways—single, double, and triple—and with as much truth as if done from mathematical draughts; yet the only instrument we have seen are a chisel and an axe, both made of stone. Their fancy, indeed, is very wild and extravagant, and I have seen no imitations of nature in any of their performances, unless the head and the heart-shaped tongue hanging out of the mouth of it may be called natural.

"We saw many beautiful parrots and birds of various kinds—one in particular that had a note very much like our blackbird, but we found no ground fowl or domestic poultry. Of quadrupeds we saw no other than dogs, which were like those on the island of Otaheite, and of them but a few. * * * From the view which we had of the coast, and the observations made, we might judge that the country is well-situated, naturally fertile, and capable of great improvement by cultivation, especially as the climate is distinguishably mild and favourable. We had clear and fair weather all the time we were on the coast, excepting one day, and though the weather was hot, yet it seemed, by what we observed, that a sea-breeze constantly set in about eleven o'clock in the forenoon which moderated it.

"On the 30th, having obtained a sufficient quantity of wood and water, we left the bay, and, sailing along the coast, about noon came up with a point of land before an island; this point we called East Cape, and the island East Island, from which the land altered its direction and tended away to the W. We saw several villages which seemed to have been fenced in by art, and some parcels of ground cultivated. We passed a bay which

we called Hicks's Bay, after our first lieutenant. On the 31st we sailed along the coast and had light breezes and pleasant weather. In the forenoon seven canoes came off to us in a hostile manner, brandishing their lances and waving their paddles. One of these canoes was very large and had between fifty and sixty people in her; some of them gave us an *heivo*; and one of them—a priest, as we supposed—talked very much. They kept paddling about us, calling out to us that, if we would go on shore, they would beat us with their patta-pattoos, and, being apprehensive that if we suffered them to approach nearer to us we might be obliged to offer violence to them, the captain ordered a gun, loaded with grape-shot, to be fired over their heads, the report of which terrified them so much that they paddled away till they had got, as they supposed, out of our reach, and then they stopped and held a consultation, after which they seemed as if they intended to return, and we fired another gun loaded with ball, and then they made as fast as possible to the shore. Being at this time off a cape, we named it, from the hasty retreat of the natives, Cape Runaway.

"On the 1st of November a great number of canoes came off us, one of which had part of a human skull to bale out the water with. We prevailed on some of the natives to come alongside of the ship, and traded with them for cloth, crayfish, and mussels. They gave us several *heivos*, but some of them seemed to threaten us. A breeze springing up we left them, and a little further on the coast another squadron of fisher boats came off to us, with whom also we had some traffic. These, as well as the rest, were very ready to snatch anything they could lay their hands on; and, watching an opportunity, they stole a pair of sheets that were tied by a line at the ship's stern, and were going off with them, upon which we fired several muskets, but they did not much regard them. We then fired some grape-shot amongst them, and they paddled away something faster, till they imagined themselves out of our reach, and then they held up their paddles and seemed to defy us. We fired another gun loaded with round and grape-shot, which passed between two canoes and narrowly missed them, on which they hesitated no longer, but repaired immediately to the shore. Toward night we were near a small island, called by the natives Mowtohora, about three leagues from the land. In going between this and the mainland, a canoe came off from the island. This canoe was double, and differed in other respects from those we had seen before. After we had talked with the people which came in it a considerable time, they gave us several *heivos*, then looked at us very steadfastly, and, having threatened us, stood off towards the mainland. Opposite to this is a high-peaked hill, which we named Mount Edgecombe; and a small bay, which we called Lowland Bay; and the two points thereof, from their situation, Highland

Point and Lowland Point, the latter of which stretches a great way, and is covered with trees. Near it there are three small islands or rocks, and it was with difficulty that we steered clear of them in the night, and got into six fathoms water, soon after which we made a point of land, which we called Town Point. This was at the entrance of a little cove.

"On the 2nd, in the morning, we discovered three sorts of land; but, as the weather was hazy, could not make many observations. We also passed three other islands: one of them was rocky, high, and barren, which we called White Island. The other two were lower; one of them we named Flat Island, in which we saw a village. A canoe pursued us, but, having a brisk breeze, it could not overtake us. Toward night it blew pretty hard, right on shore; we therefore tacked about, and sailed backward and forward till the next morning, the 3rd. Then the canoe which we saw the night before gave us chase again. Having a sail, they at length came up with us; sailed alongside of us for a considerable time, and now and then gave us a song, the tune of which was much like the chant which some priests use. They also gave us a *heivo*, but soon after threw some stones at us; we fired a musket, loaded with small shot, at a young man which distinguished himself at the sport, and he shrunk down as if he had been wounded. After a short consultation they doused the sail, and stood back for an island. We sailed along with a moderate breeze, and passed a cluster of rocks, which we called the Court of Aldermen; and, from the vicinity of one of the three last-mentioned islands to them, we gave it the name of the Mayor. This cluster of rocks lies off a point of land, and terminates the bounds of this large bay to the north-west, which, from the number of canoes that came off to us, bringing provisions, we named the Bay of Plenty.

"The coast hereabout appeared very barren, and had a great number of rocky islands, from which circumstance we named the point Barren Point. The land is very grotesque, being cleft or torn into a variety of strange figures, and has very few trees upon it. About noon several canoes came off to us, and the people in them were so daring as to throw a lance into the ship, but we fired a musket, and they paddled away from us. Their canoes were formed out of one tree, and shaped like a butcher's tray, without any ornament about them. The people, who were naked, were of a very dark complexion, and made a mean appearance. We stood in for a bay, and at night anchored in it, having seven fathoms water. Several canoes like the former followed us; they were very merry, and gave us several *heivos*, or cheers. This bay, which the inhabitants call Purangi, is the best harbour we have found, being well land-locked, and with a good landing at the watering-place.

"On the 4th, early in the morning, we were visited by several canoes; the people in them, about 135 in number, had a few arms, but seemed unresolved what to do. At last they traded with us, exchanging the few trifles they had brought for cloth. They were very sly, and attempted to cheat us. We fired several muskets at them, and wounded two of them; the rest, however, did not seem to be alarmed till the captain shot through one of the canoes, which struck them with a panic, and on firing a great gun they made off to land.

"On the 9th, a great number of the natives came in canoes about the ship and brought us a large quantity of fish, mostly of the mackerel kind, with a few John Dories, and we pickled down several casks full of them. Some of these canoes came from another part of the country, which were larger and of a better sort than the rest; the people in them, too, had a better appearance; among whom were some of superior rank, furnished with good garments, dressed up with feathers on their heads, and had various things of value amongst them which they readily exchanged for Otaheite cloth. In one of the canoes there was a very handsome young man of whom I bought some things; he seemed by the variety of his garments, which he sold one after another till he had but one left, to be a person of distinction among them; his last garment was an upper one, made of black and white dogskin, which one of the lieutenants would have purchased, and offered him a large piece of cloth for it, which he swung down the stern by a rope into the canoe; but as soon as the young man had taken it, his companions paddled away as fast as possible, shouting and brandishing their weapons as if they had made a great prize, and, being ignorant of the power of our weapons, thought to have carried it off securely; but a musket was fired at them from the stern of the ship; the young man fell down immediately, and, it is probable, was mortally wounded, as we did not see him rise again. What a severe punishment of a crime committed, perhaps, ignorantly! The name of this unfortunate man, we afterwards learned, was Te Riunui.

"The wind having been against us for several days, and as we could get no farther with our heavy ship, on the 29th in the morning, having weathered a long point of land, which we named Cape Brett, we bore away to leeward, got into a very large harbour where we were land-locked, and had several pretty coves on every side of us. We passed a small island which we named Piercy Island, and soon after cast anchor. Many canoes came off to us, and the people in them, according to custom, behaved somewhat unruly. While I saluted one of them, in their manner, he picked my pocket. Some of our people fired upon them, but they did not seem to regard it much. One of our boats went on shore, and then they set off all at once and attempted to

seize her, in which, however, they failed; but soon after Mr. Banks got on shore he had like to have been apprehended by one of the natives, but happily escaped. The marines fired upon them, five great guns were fired from the ship, and Te Kuku, son to one of their chiefs, was wounded in the thigh."*

"On the 5th a canoe came into the bay that had eighty people in her, most of whom paddled; the chiefs wore garments of dog-skins, and were very much tattooed. We saw many plantations of the kumera, and some of the aute, or cloth trees. At night again it was almost calm, and we were near the shore. We designed to tack about but were hurried by an eddy tide upon the breakers off a point of land called by us Point Pococke, before we were aware of it, which threw us into a panic and occasioned great confusion. Not having room to anchor we hoisted out the pinnace to tow her off; we thought we had seen a whale but it proved to be a rock, and we struck upon it twice. We got clear of it again and streamed the buoy, but luckily did not let go the anchor.

"On the 15th January we anchored in a snug cove in a bay on the south side of Cook's Straits. The woods here abound with divers kinds of birds, such as parrots, wood-pigeons, water-hens, three sorts of birds having wattles, hawks, with a variety of birds that sing all night. We also found a great quantity of a species of *Philadelphus*, which makes a good substitute for tea. At one particular place we met with a substance that appeared like a kid's skin, but it had so weak a texture that we concluded it was not leather, and were afterwards informed by the natives that it was gathered from some plant called Ti kume; one of them had a garment made of it which looked like their rug cloaks. The natives in this part of New Zealand wear large bunches of feathers on their heads and their garments in a singular manner, just as Abel Tasman, the person who, about 150 years ago, discovered this land, has figured in his work. They were not desirous of anything we had except nails, which they soon discovered to be useful. When these people are pleased on any particular occasion they express it by crying *Ai*, and make a cluck with their tongues not unlike a hen's when she calls her chickens. While we lay here some of our people went towards the *pa* in a boat; several of the natives came out to welcome them; most likely they took it to be a traverse, and Mr. Monkhouse shot at them. An old man came in a few days after and told us that one person was dead of a wound which he received. In this *pa* there were about thirty-two houses, containing upwards of 200 inhabitants.

* The plate containing the likeness of this young man shows a style of tattooing which has become scarce, if not wholly extinct. I have seen but few specimens, and those more than thirty-five years back.

"On the 7th February we weighed anchor and proceeded along the straits with the tide and a fine breeze which set us through with great rapidity, and, being willing to satisfy ourselves whether the north part of this land was an island, we resolved to sail as far N. as Cape Turnagain. The two easternmost points of the straits we called Cape Campbell and Cape Palliser. On the 8th we sailed along the south coast of the (North) Island. In the afternoon three canoes came off to us—two of them were large and handsome. The natives in them behaved peaceably, and, by asking for nails, we concluded they had heard of us from the people of some other islands where we had been. They were very much like the natives of Mataruukau, a village in Tolago Bay, being very neatly dressed, having their hair knotted on the crown of their heads in two bunches, one of which was *Tamoou*, or plaited, and the wreath bound round them the same. In one of the canoes there was an old man who came on board attended by one of the natives: he was tattooed all over the face with a streak of red paint over his nose and across his cheek. His brow, as well as the brows of many others who were with him, was much furrowed; and the hair of his head and beard quite silvered with age. He had on a flaxen garment ornamented with a beautiful wrought border, and under it a petticoat made out of a sort of cloth which they call "*Aooree Waow*;" on his ears hung a bunch of teeth, and an ear-ring of poonamoo or greenstone. For an Indian, his speech was soft, and his voice so low that we could hardly hear it. By his dress, carriage, and the respect paid to him, we supposed him to be a person of distinction amongst them. On the 9th, at noon, we had a good view of Cape Turnagain. We passed two points of land to which we gave the names of Castle Point and Flat Point.

"On the 14th we passed Cook's Straits, without seeing them, on the east side of Te wai pounamu. In the afternoon four double canoes, in which were fifty-seven people, came off to us; they had some leaves about their heads, but few clothes on their bodies. They kept aloof from us; nor could we persuade them to traffic with us. Having beat to windward for several days without gaining any way, with the weather gloomy and very cold, on the 24th we had a fresh breeze from the N. which carried us round the outermost point of the land we had seen, which we called Cape Saunders, beyond which the land tended away to the S.W. On the 4th March, after having beat about near a week, we got sight of land again and saw the appearance of a harbour which we named Molineux's Harbour, after the name of the master of our ship. We had light breezes and calms till the 9th, and, at the dawn of that day, we narrowly escaped running the ship upon a ledge or parcel of craggy rocks, some of which were but just seen above water. They were luckily discovered by the midshipman's going

to the masthead. The breeze being moderate we put the helm a-lee, and were delivered from this imminent danger by the good providence of God. * * * We stood out to sea, but, meeting with contrary winds, we beat to windward for a considerable time; at length, the wind coming fair, we steered westerly, and unexpectedly found ourselves between two large shoals which had some rocks upon them, but we fortunately escaped them. We called these shoals the Traps. This day being one of the inferior officers' birthday, it was celebrated by a peculiar kind of festival; a dog was killed that had been bred on board; the hind-quarters were roasted, and a pye was made of the fore-quarters, into the crust of which they put the fat; and of the viscera they made a haggis."

On the 31st March Captain Cook and his party left New Zealand on their homeward voyage, and on the 6th May we have the following entry in our artist's journal when on the coast of New Holland:—"On this day Forbes Sutherland, a native of the Orkneys, who had departed this life, was carried on shore and decently interred." And on the 22nd of the same month this strange entry:—"This day the captain's clerk had his ears cut off, and also his clothes cut off his back." To which is added in a note:—"The captain and officers offered some time after, at Batavia, a reward of fifteen guineas to any one who should discover the person or persons who cut off his ears, and fifteen gallons of arrack to any one that should discover him or them who had cut off his clothes." And afterwards, in December, while at Batavia, an entry in the journal thus;—"One of our midshipmen ran away from us here, and it was suspected that he was the person who cut off Orton's ears."

After having been wrecked off the coast of New Holland, and with the greatest difficulty saving the ship, and then, taking out all her cargo, running her on shore and repairing her, which was accompanied with severe labour and hardship, they anchored in the road of Batavia on the 10th of October, where the ship was examined and repaired. During this time several died, and Mr. Parkinson makes this entry:—"While our ship was repairing, three of the crew died; also, Tupaea and the lad Taiota, natives of Otaheite, whom we designed to have brought to England. Before our arrival at Batavia, they had made great progress in the English tongue, in which they were greatly assisted by Mr. Green, the astronomer, who took much pains therein, especially with Taiota. When Taiota was seized with the fatal disorder, as if certain of his approaching dissolution, he frequently said to those of us who were his intimates, 'My friends, I am dying!' He took any medicines that were offered him; but Tupaea, who was ill at the same time, and survived him but a few days, refused everything of that kind, and gave himself up to grief, regretting in the highest degree that he

had left his own country; and when he heard of Taiota's death, he was quite inconsolable, crying out frequently, 'Taiota! Taiota!' They were both buried in the island of Eadam. During our stay at Batavia, most of us were sickly; Mr. Monkhouse, our surgeon, and the astronomer's servant also died, and some others hardly escaped with life."

On the 26th December they left Batavia, and on the 5th January arrived at Prince's Island, where they stayed about ten days. At this place ends S. Parkinson's Journal.

Captain Cook says:—"In the morning of the 26th we weighed and set sail. At this time the number of sick on board amounted to forty, and the rest of the ship's company were in a feeble condition. Every individual, including myself, had been sick, except the sailmaker, an old man between seventy and eighty years of age, and it is very remarkable that this old man, during our stay at this place, was constantly drunk every day. * * We now made the best of our way for the Cape of Good Hope, but the seeds of disease which we had received at Batavia began to appear with the most threatening symptoms in dysenteries and slow fevers. Mr. Banks was among the sick, and for some time there was no hope of his life. We were very soon in a most deplorable condition; the ship was nothing better than a hospital, in which those that were able to go about were too few to attend the sick, who were confined to their hammocks; and we had almost every night a dead body to commit to the sea. In the course of about six weeks we buried Mr. Sporing, a gentleman who was in Mr. Banks's retinue, *Mr. Parkinson, his natural history painter*, Mr Green, the astronomer, the boatswain, the carpenter and his mate, Mr Monkhouse the midshipman (who had fothered the ship after she had been stranded on the coast of New Holland), our jolly old sailmaker and his assistant, the ship's cook, the corporal of marines, two of the carpenter's crew, a midshipman, and nine seamen; in all twenty-three persons, besides the seven that we buried at Batavia."

A few more sentences from Captain Cook:—"On the 15th March we anchored off the Cape of Good Hope, having only six men capable of doing duty,* so that we could not send our boat on shore. * * Having lain here to recover the sick and procure stores till the 13th of April, I then got all the sick on board, several of whom were still in a dangerous state; I unmoored and got ready to sail, having engaged some Portuguese to supply the loss of our sailors. The next evening I anchored under Robin Island. On the 25th we weighed and put to sea. About an hour afterwards we lost our master, Mr. Robert Molineux, a young man of good parts but unhappily given up to intemperance, which

* Parkinson's Journal, p. 210.

brought on disorders that put an end to his life. On the 1st of May we anchored at St. Helena, where we remained till the 4th, when we weighed and put to sea. On the 23rd died our first lieutenant, Mr. Hicks. Our rigging and sails were now become so bad that something was giving way every day. We continued our course, however, in safety till the 10th of June, when land, which proved to be the Lizard, was discovered by Nicholas Young, the same boy that first saw New Zealand, and on the 12th came to an anchor in the Downs; after having been absent from England within a few days of three years, when we immediately sent our sick on shore."

Voyagers in our day can form but a very poor conception of what Cook and his companions had daily to endure during their three years' voyage in the "Endeavour." From New Zealand at that time, though much in want of fresh supplies, they could get little besides fish, and wood, and water, and some sea-side weeds as vegetables. They also got with difficulty a few sweet potatoes; this, however, was owing to its being the wrong season of the year for kumera, being just the planting season, at which time the natives themselves have very few (if any) to use as food. And the New Zealand forests afforded no good edible fruits. By Captain Cook and his officers, as we have seen, a dog was considered a great luxury; and the rank weeds of our shores, wild celery, and scurvy-grass (*Apium australe*, and *Lepidium oleraceum*), most welcome vegetables!

During their eventful voyage they lost just two-fifths of their number, including a large majority of their officers and principal men, none of whom were killed in battle or lost their lives through storms or dangers. They lost the first lieutenant, the master, the chief mate, two midshipmen, the boatswain, the sailmaker and his assistant, the carpenter, the carpenter's mate and two of his crew, the ship's cook, and sixteen seamen; also, the corporal of marines, the surgeon, the astronomer, the two draughtsmen, and Mr. Banks's secretary, also his negro servant, and the two Tahitians, Tupaea and Taiota—making a sad total of thirty-eight! and, possibly, some more of the sick who were carried on shore. Well might Captain Cook call his ship a "floating hospital!"

The names, however, of those officers and gentlemen live here among us in the bays and isles and headlands named after them by Captain Cook. The islet at Anaura (which, as Parkinson said in his journal, "somewhat sheltered their ship" when they first got water in New Zealand) was named after our artist, just as the other small island in the adjoining bay of Tolago was named after Mr. Banks's secretary, Mr. Sporing.* "*Parkinson Islet*" is so named in the very neat map of New Zealand in Sydney Parkinson's journal; but, curiously enough, while the islet is correctly given in the

* I find, from Dr. Sparrman's Voyage, that Mr. Sporing was a Swede.

larger map of New Zealand in Cook's First Voyage, the *name* is *omitted*, while *all* the other small single islets along the coast seen by them, from Bare Island to the Mayor, have their names inserted. Is this another indication of that "mean and invidious suppression" on the part of Dr. Hawkesworth and Mr. Banks (complained of by the editor of the "Journal"), which feeling caused them to disallow the insertion of Sydney Parkinson's name at the corner of his engraved drawings? Possibly it may be so. I have also noticed that a *few* engravings in Cook's *First* Voyage of articles taken home in the ship, and of subjects *got up* in England, bear the names of their designers or copyists—which makes the omission of our artist's name the more glaring. If such, as I have ventured to suppose, really be the case, it is doubly mean and paltry on their part, as Sydney Parkinson, *our* artist (who died in Mr. Banks's service), could never in any way have injured them.

His name is but twice mentioned in Dr. Hawkesworth's narrative of the first voyage: once, briefly, that of his death (which I have already quoted), and once shortly after their arrival at Tahiti, which is as follows:—"Our residence on shore would by no means have been disagreeable if we had not been incessantly tormented by the flies, which, among other mischief, made it almost impossible for Mr. Parkinson, Mr. Banks' natural history painter, to work; for they not only covered his subject so as that no part of the surface could be seen, but even ate the colour off the paper as fast as he could lay it on. We had recourse to mosquito-nets and fly-traps, which, though they made the inconvenience tolerable, were very far from removing it."*

In conclusion, I will merely say, as my firm belief, that our young disciple of nature and the first artist who visited these shores of New Zealand, and who so faithfully depicted what he saw with both his pencil and his pen, will yet have justice done him. When, in days to come, the history of New Zealand shall be fully and truthfully written, then the names of Cook and his gallant companions can not be forgotten; and prominently among that faithful and devoted band shall be found the name of our young artist, Sydney Parkinson.

"To live in hearts we leave behind,
Is not to die ——."

* Cook's Voyages: p. 97, vol. II.

ART. X.—*Notes, chiefly historical, on the ancient Dog of the New Zealanders.* By W. COLENSO, F.L.S.

[*Read before the Hawke Bay Philosophical Institute, 8th October, 1877.*]

FOR several years I have been aware of much error being commonly entertained concerning the original New Zealand dog, and I have been desirous of combatting it, as far as I could, by putting together what little I have learned respecting it, and the valuable testimonies yet extant of those of our earliest voyagers in these seas who frequently saw the animal. And this, I cannot help thinking, is the more needed just now; for, in the last volume of the "Transactions," there is a paper by Dr. Hector "On the remains of a dog found near White Cliffs, Taranaki," in which there are some statements and remarks concerning the New Zealand dog, which, I think, will be found incorrect—*e.g.*, where Dr. Hector says :—"A few dogs of this primitive breed were known within the last twenty years," that "it is improbable that the same dogs were both highly-prized domestic pets and also used for food;" and "a bitch and full-grown pup were known for several years in the densely-wooded country between Waikawa and the Mataura plains, and did great damage among the flocks of sheep, etc., they were (at last) shot and presented to the Colonial Museum. Of the smaller specimen both skin and skeleton were taken to the British Museum by Sir G. Grey, and the skin of the mother was preserved here, and has been recognised by many old Maoris as a genuine *kuri* or ancient Maori dog. * * * It is a large-bodied dog with slender limbs, large ears, etc."*

From an early period (in our modern times) I travelled pretty much in this North Island of New Zealand (particularly from 1834 to 1854), and that always on foot, zig-zagging about and visiting the Maori pas and villages in the interior and on the coast from Cook Straits to Cape Maria Van Diemen, and often crossing the island from sea to sea. I mention this, because I failed to see a single specimen of the true Maori dog, although I made every exertion to obtain one, offering, too, a high price. But they had become wholly extinct, or very nearly so, at least fifty years ago.

Notwithstanding, I have seen and possessed its hair; for, about the year 1835, I obtained an ancient, large, and handsome chief's staff and weapon of defence,† which was richly ornamented with carving, red feathers from under the wings of the parrot (*Nestor meridionalis,*) and the flowing hair of the old Maori dog. This hair was long, fine, and white, beautifully and securely done up in little queues having their ends firmly bound round with the finest spun flax where secured to the weapon, neatly covered with the

* "Trans. N.Z. Inst.," IX., 243, 244.

† *Hani*, *Taiaha* or *Maipi*, of the natives.

red feathers which were also singly and firmly fixed by being closely woven into a bit of strong flaxen cloth made especially for that purpose.

To a paper which I wrote on the *moa* in the year 1842, I added the following note:—"The New Zealand dog *(kuri)* is a small animal (somewhat resembling the variety known as the pricked-ear shepherd's cur) with erect ears and a flowing tail; its cry is a peculiar kind of whining howl, which, when in a state of domestication, it utters in concert at a signal given by its master, and it is most unpleasant. This variety of dog has, however, become very scarce in consequence of the continued introduction of other and larger varieties."* At that time I supposed that some of the many dogs I had seen in my early travels were of the old New Zealand or South Sea breed; but, since then, I have had good and ample reasons for believing I was mistaken. It was, however, quite possible, or even probable, that those dogs alluded to by me in my old note quoted above, were mongrel half-breeds, or mixed descendants of the New Zealand and the introduced foreign dogs. And it is such dogs or others like them, but with still less of the true Maori breed in them, that have deceived later enquirers and the early settlers.

I may also mention that I have both seen and heard wild dogs in the forests and on their outskirts when travelling. Those, however, were dogs of a different kind—mongrels of various sorts—which had run away from their Maori masters, or had stayed behind in the woods when out pig-hunting with them, and so by degrees had become wild and increased in number. And as pigs were now becoming plentiful in the country, and their flesh (almost the natural food of the dog) easily obtained—while in the pas or villages those curs were often very badly off—it was no marvel that some of those dogs ran away and became wild. I remember particularly being beset on two or three occasions by tolerably large packs of those wild dogs, between the Ruahine mountain range and the Ruataniwha plains, in the years 1846-7. One of those packs were eleven in number, and being unarmed, save with my stick, I had some difficulty in keeping them off. I was alone too at the time, as my Maori baggage-bearers had lagged behind, and my own dog, which was much bigger, would not look at them, but kept behind me, which no doubt was one of the causes of their so persistently following me up and closing round me. I thought so much of it that I sent to England for double-barrelled pistols (revolvers then not being known—to me, at least) for a future occasion, as my regular travelling lay in that direction and over the mountain range. It was these wild dogs of that mongrel kind that did mischief to the flocks of the early settlers

* Published in "Tasmanian Journal of Natural Science," vol. II., p. 97; and in "Annals of Natural History" (London), vol. XIV., p. 93.

in some places, and I believe that the two dogs shot near Mataura (mentioned by Dr. Hector) were of this description.

So long back as 1814-15, Mr. Nicholas, who visited New Zealand in company with the Rev. S. Marsden, made a similar error. He says:—"On our return from the place where we cut down the spars, we met one of the native dogs running about in a wild state. It was considerably larger than any of the dogs that we had seen domesticated among them, and bore a strong resemblance to the shepherd's dog so well known in England. The moment it came in sight of us it set up a terrific howling, and never ceased the same baleful discord till we had left the place. There are numbers of dogs running wild in this manner through the different parts of the island, but I could not discover that they ever offered any injury to the inhabitants, who prize them very highly, as well for the sake of their flesh, which serves them for a delicious article of food, as for their hide and bones, which they convert to a variety of purposes, in the way of ornamental devices."* Both Mr. Marsden and Mr. Nicholas, who spent some months together in New Zealand, and travelled too, pretty much—from Hokianga to the Thames—seemed never to have seen a single New Zealand dog of "the primitive breed."

Captain Cook does not give many particulars concerning the South Sea dog in his voyages, although he had frequent opportunities of both seeing and eating it! Fortunately, however, he was during his first two voyages round the world accompanied by scientific men, who have left on record many interesting remarks respecting this animal. On his first voyage, Cook was accompanied by Sir Joseph Banks, Dr. Solander (a Swedish naturalist), and a talented young artist named Sydney Parkinson; this last-named gentleman has given us several particulars in his separately-published journal of that first voyage. On his second voyage, Cook was accompanied by two eminent German naturalists, father and son (J. R. and G. Forster), and by Dr. Sparrman, another celebrated scientific Swede. And the two German gentlemen have also recorded much about our New Zealand dog, which they published in their large and separate works about their voyage.† On his third voyage Cook had with him Mr. Anderson, who was the surgeon on board of his ship, and who also acted as naturalist. From these independent accounts, written by persons who had ample opportunities of seeing and knowing all about our New Zealand dog, and who also understood what they were writing, I purpose making copious extracts, to

* Nicholas' "Narrative of a Voyage to New Zealand," vol. II., p. 126.

† "Voyage round the World," by G. Forster, 2 vols., 4to; "Observations made during a Voyage round the World," by J. R. Forster, 4to.

which I am the more inclined seeing the books themselves are very scarce and scarcely even known by name in the colony.

The South Sea dog was first seen by Captain Cook and his companions at Tahiti; and it is worthy of something more than a mere passing notice to bear in mind, that, while it was also found by them here in New Zealand, there were several intervening islands and groups at which Cook called where the dog was not found. Generally speaking, the natives of the various Polynesian isles he visited possessed three domestic animals—the pig, the dog, and the common poultry fowl; but few possessed all three: some had but two, and some (as New Zealand) only one. And yet it seems to me pretty evident that the natives of those isles in which one or two of those animals were wholly wanting, both knew and gave the right common name for them to Cook's party when they saw the animal for the first time in his ship!

Captain Cook, on his first voyage anchored at Tahiti on the 10th April, 1769, and though he and his party were daily on shore and had strolled miles in the country to visit plantations and villages, and had also held daily markets for purchasing food, etc. of all kinds which the islanders brought for sale, yet his first entry concerning the South Sea dog was on the 20th of June! which, being in every respect peculiar, I may in part copy. Writing of Operea, a great lady of the island, he says:—"As the most effectual means to bring about a reconciliation between us, she presented us with a hog and several other things, among which was a dog. We had lately learnt that these animals were esteemed by the Indians as more delicate food than their pork, and upon this occasion we determined to try the experiment. The dog, which was very fat, we consigned over to Tupaea, who undertook to perform the double office of butcher and cook. He killed him by holding his hands close over his mouth and nose, an operation which continued over a quarter of an hour. While this was doing an oven was made in the ground. * * The dog, being well cleaned and prepared, with the entrails and blood in cocoa-nut shells, was then placed in the oven: in about four hours it was opened and the dog taken out excellently baked, and we all agreed that he made a very good dish. The dogs which are here bred to be eaten taste no animal food, but are kept wholly upon bread-fruit, cocoa-nuts, yams, and other vegetables of the like kind. * * We all agreed that a South Sea dog was little inferior to an English lamb; their excellence is probably owing to their being kept up and fed wholly upon vegetables. * * Here are no tame animals except hogs, dogs, and poultry, and these are by no means plentiful."*

Sydney Parkinson, however, has an earlier entry than this, made in

* Cook's Voyages, 4to. ed., 1773, vol. II., pp. 152, 196.

April, which (in part) is also worth copying. He says :—"Those people also are fond of dog's-flesh, and reckon it delicious food, which we discovered by their bringing the leg of a dog roasted to sell. Mr. Banks ate a piece of it and admired it much. He went out immediately and bought one and gave it to some Indians to kill and dress it in their manner, which they did accordingly. * * At night it was served up for supper, I ate a little of it, it had the taste of coarse beef, and a strong disagreeable smell; but Captain Cook, Mr. Banks, and Dr. Solander commended it highly, saying it was the sweetest meat they had ever tasted, but the rest of our people could not be prevailed on to eat any of it. We have invented a new dish, which is as much disliked by the natives as any of theirs is by us. Here is a species of rats, of which there are great numbers in this island. We caught some of them and had them fried. Most of the gentlemen in the bell-tent ate of them, and commended them much, and some of the inferior officers ate them in a morning for breakfast." And, subsequently, on their passage thence to New Zealand, we have also this entry in his Journal :—"On the 27th August we killed a dog, and dressed him, which we brought from Ulietea (Raiatea): he was excessively fat, although he had eaten nothing while he had been on board"* (nearly twenty days).

On shore at Tolago Bay, Cook and his party first saw the New Zealand dog. Cook says :—"No tame animals were seen among the natives except dogs, which were very small and ugly." And, again, on leaving Tolago, he says :—"We saw no four-footed animals, nor the appearance of any, either tame or wild, except dogs and rats, and these were very scarce; the people eat the dogs like our friends at Tahiti."

Parkinson's entry in his Journal at Tolago respecting the dog is :—"Of quadrupeds we saw no other than dogs, which were like those on the island of Tahiti, and of them but a few." Another entry of his in his Journal respecting a dog, made in March, on leaving the south coasts of New Zealand (on the day they discovered those dangerous shoals called the "Traps"), is also worthy of notice. Parkinson says:—"This day the weather was more moderate than it had been for many days, and being one of the inferior officers' birthday, it was celebrated by a peculiar kind of festival; a dog was killed that had been bred on board; the hind-quarters were roasted, and a pye was made of the fore-quarters, into the crust of which they put the fat; and of the viscera they made a haggis!" (We must remember that Parkinson was a Scotchman).

From George Forster (who, with his father, J. R. Forster, accompanied Cook on his second voyage), we gain good information respecting the New Zealand dog. He first saw them in Queen Charlotte Sound, before their

* S. Parkinson's Journal of a Voyage to the South Seas, pp. 20, 81.

ship had visited Tahiti, and (speaking of some natives who visited their ship) he says:—"A good many dogs were observed in their canoes, which they seemed very fond of, and kept tied with a string round their middle; they were of a rough long-haired sort with pricked ears, and much resembled the common shepherd's cur or Count Buffon's *chien de berger* (see his *Hist. Nat.*) They were of different colours—some spotted, some quite black, and others perfectly white. The food which these dogs receive is fish, or the same which their masters live on, who afterwards eat their flesh and employ the fur in various ornaments and dresses. They sold us several of these animals, among which the old ones coming into our possession became extremely sulky and refused to take any sustenance, but some young ones soon accustomed themselves to our provisions."* And, again, shortly after, he says:—"While here we saw a large animal in the water about Grass Cove which seemed to be a sea-lion by its magnitude, but which we could not get a shot at. We had already discovered a small species of bats in the woods, so that the list of the indigenous quadrupeds in New Zealand was increased to five, including the domestic dog of the natives." On leaving Cook Straits for Tahiti, Forster says:—"The officers, who could not yet relish their salt provisions after the refreshments of New Zealand, had ordered their black dog (mentioned p. 135)† to be killed, and sent the captain one-half of it; this day, therefore, we dined for the first time on a leg of it roasted, which tasted so exactly like mutton that it was absolutely undistinguishable. In our cold countries where animal food is so much used, and where to be carnivorous perhaps lies in the nature of men, or is indispensably necessary to the preservation of their health and strength, it is strange that there should exist a Jewish aversion to dogs' flesh, when hogs, the most uncleanly of all animals, are eaten without scruple. * * * It may be objected that the exalted degree of instinct, which we observe in our dogs, inspires us with great unwillingness to kill and eat them. But it is owing to the time we spend on the education of dogs that they acquire those eminent qualities which attach them so much to us. * * * In New Zealand, and (according to former accounts of voyages) in the tropical isles of the South Sea, the dogs are the most stupid, dull animals imaginable, and do not seem to have the least advantage, in point of sagacity, over sheep, which are commonly made the

* Forster's Voyage round the World, 4to. (London), 1677, vol. I., p. 219.

† At p. 135, Forster says:—"Here at Dusky Bay we had a young dog with us, which the officers had got at the Cape of Good Hope, and intended to try whether we could not train him up to the gun, but we had no sooner discharged the first fowling-piece than he ran into the woods and would not return, though we used all possible means to recover him." I suppose they managed to do so before they left Dusky Bay.

emblems of silliness. In New Zealand they are fed upon fish, in the tropical isles on vegetables, and both these diets may have served to alter their disposition. Education may perhaps likewise graft new instincts; the New Zealand dogs are fed on the remains of their masters' meals; they eat the bones of other dogs, and the puppies become true cannibals from their birth. We had a young New Zealand puppy on board, which had certainly had no opportunity of tasting anything but the mother's milk before we purchased it; however, it eagerly devoured a portion of the flesh and bones of the dog on which we dined to-day; while several others of the European breed, taken on board at the Cape, turned from it without touching it." A little further on, he says:—"On the 4th August a young bitch of the terrier breed, taken on board at the Cape of Good Hope, brought ten young ones—one of which was dead. The New Zealand dog, mentioned above, which devoured the bones of the roasted dog, now fell upon the dead puppy, and ate of it with a ravenous appetite. This is a proof how far education may go in producing and propagating new instincts in animals. European dogs are never fed on the meat of their own species, but rather seem to abhor it. The New Zealand dogs, in all likelihood, are trained up from their earliest age to eat the remains of their masters' meals; they are therefore used to feed upon fish, their own species, and perhaps human flesh; and what was only owing to habit at first may have become instinct by length of time. This was remarkable in our cannibal-dog, for he came on board so young that he could not have been weaned long enough to acquire a habit of devouring his own species, and much less of eating human flesh; however, one of our seamen having cut his finger, held it out to the dog, who fell too greedily, licked it, and then began to bite into it."

About a month after this, at Huahine, he says:—"We collected upwards of twenty hogs this day for large spike nails, and about a dozen of dogs, which seemed to be the most stupid animals of their kind, but were reckoned most excellent provision by the natives." At this island dogs were in great plenty. Forster says:—"Dr. Sparrman and myself in our walk saw great numbers of hogs, dogs, and fowls. The last roamed about at pleasure through the woods, and roosted on fruit trees; the hogs were likewise allowed to run about, but received regular portions of food, which were commonly distributed by old women. We observed one of them feeding a little pig with the sour fermented bread-fruit paste, called *mahei*. She held the pig with one hand, and offered it a tough pork-skin, but as soon as it opened the mouth to snap at it, she contrived to throw a handful of the sour paste in, which the little animal would not take without this stratagem. The dogs, in spite of their stupidity, were in high favour with all the women, who could not have nursed them with a more ridiculous affection if

they had really been ladies of fashion in Europe. We were witnesses of a remarkable instance of kindness, when we saw a middle-aged woman, whose breasts were full of milk, offering them to a little puppy which had been trained up to suck them. We were so much surprised at this sight that we could not help expressing our dislike of it; but she smiled at our observation, and added that she suffered little pigs to do the same service. Upon enquiry, however, we found that she had lost her child, and did her the justice among ourselves to acknowledge that this expedient was very innocent, and formerly practised in Europe. The dogs of all these islands were short, and their sizes vary from that of a lap-dog to the largest spaniel. Their head is broad, the snout pointed, the eyes very small, the ears upright, and their hair rather long, lank, hard, and of different colours, but most commonly white and brown. They seldom, if ever, barked, but howled sometimes, and were shy of strangers to a degree of aversion."

Again he says:—"The quantity of live stock which we had purchased during our stay there was amazing. * * * The 'Resolution' alone had 209 live hogs, 30 dogs, and about 50 fowls on board when she sailed; and the 'Adventure' had not much less." And a little further on he says: —"The want of room occasioned the death of several hogs; and the obstinacy of the old dogs in refusing to take any sustenance deprived us of the greatest number of those animals." About a month after, when their ship was near to the coast of New Zealand, he says:—"Some of our people who examined the pump-well found there a dog, which they brought up on deck. This creature, which had been purchased at the island of Huahine, like many others of the same species, had obstinately refused to take any nourishment, and in all probability had lived ever since in that hole without the least support of food for a space of thirty-nine or forty days. The whole body was reduced to a mere skeleton, the legs were contracted, and he voided blood at the anus. The torments in which this poor animal must have lived were a lesson to our people to purchase only young puppies of this race for the future, as the grown dogs constantly refused to eat on board."

The elder Forster in his work also says:—"The dogs of the South Sea isles are of a singular race; they mostly resemble the common cur, but have a prodigious large head, remarkably little eyes, prick-ears, long hair, and a short bushy tail. They are chiefly fed with fruit at the Society Isles; but in the low isles and New Zealand, where they are the only domestic animals, they live upon fish. They are exceedingly stupid, and seldom or never bark, only howl now and then; have the sense of smelling in a very low degree, and are lazy beyond measure; they are kept by the natives chiefly for the sake of their flesh, of which they are very fond, preferring it to pork. * * * The New Zealanders continually living on fish are

glad when they can get a dog or bird to eat, which with them always is reckoned a dainty."*

Captain Cook in his Second Voyage, and while in New Zealand at anchor in Queen Charlotte Sound, incidentally remarks (when writing of the then proved cannibalism of the New Zealanders and its not being owing to their want of animal food):—"In every part of New Zealand where I have been, fish was in such plenty that the natives generally caught as much as served both themselves and us. They have also plenty of dogs; nor is there any want of wild-fowl, which they know very well how to kill." And again he says:—"While here we were visited by several strangers in four or five canoes, who brought with them fish and other articles, which they exchanged for cloth, etc. These new-comers took up their quarters in a cove near us; but very early the next morning moved off with six of our small water-casks, and with them all the people we found here on our arrival. * * * They left behind them some of their dogs and the boar I had given them the day before, which I now took back again as I had not another."

Mr. Anderson, who was with Captain Cook on his third voyage, also states that their dogs were plentiful. He says:—"It is remarkable that in this extensive land there should not even be the traces of any quadruped, only excepting a few rats and a sort of fox-dog, which is a domestic animal with the New Zealanders. * * * The natives sometimes, though rarely, find means to kill rails, penguins, and shags, which help to vary their diet. They also breed considerable numbers of their dogs (mentioned before) for food, but these cannot be considered as a principal article of diet; from whence we may conclude that, as there is not the least sign of cultivation of land,† they depend principally for their subsistence on the sea, which indeed is very bountiful in its supply."

Here, however, I would remark, that this is the only place in all his voyages and many visits to New Zealand in which Cook says, or hints, that the New Zealand dog was plentiful. In other parts of his voyages, as we have seen, he has said the contrary—that they were but few; and all the other gentlemen who had been with him in New Zealand also said the same. I think, therefore, that Captain Cook in this place speaks more rhetorically than in strict accordance with fact, being led thereto (in this sentence) in declaiming against the cannibalism of the natives. And so of the surgeon, Mr. Anderson; he had never been in New Zealand before, neither had he the opportunity of visiting the North Island (hence his erroneous remark of the New Zealanders having no cultivations!). And

* Observations made during a Voyage Round the World, 4to., London, 1778, pp. 189 and 208.

† Mr. Anderson was only in the Middle Island of New Zealand.

now, when Captain Cook again revisited his old anchorage at Queen Charlotte Sound, where he was well known, and the natives, coming from all parts in their canoes to see him, took with them all their domestic dogs, simply because they could not possibly leave them at home; and hence, on Mr. Anderson seeing so many dogs with them in their canoes, he reasonably concluded there must be plenty more at home. This trait in their character, of always taking with them in their canoes their live domestic stock, has come down to comparatively modern times. I have seen plenty of it!

Dr. Sparrman, the Swedish naturalist (who, I think, was a better zoologist than the two Forsters, judging from what he has published in English of his travels and discoveries in Africa), who also accompanied Cook in his second voyage, has unfortunately not given us any particulars of this voyage to the South Seas, although I believe such were published by him at Stockholm in his own language—at least he intimates as much in his "Voyages."* If so, perhaps some scientific gentleman of that country may ere long inform the colony of New Zealand of it.

Further: It may be also well to see to what uses the New Zealanders put their dogs besides that of using them for food. Captain Cook gives us very little information under this head, contenting himself with saying, (in his First Voyage) "that the people of Tolago Bay adorn their garments with the skins of their dogs, as we do ours with furs and ermine"—and, that "some others whom he fell in with in their canoes near Cape Brett, had weapons of stone and whalebone, and also the ribs of a whale carved, and adorned with tufts of dog's hair." Mr. Anderson also briefly says, "their work (of clothing flax-mats) is often ornamented with pieces of dog-skin; sometimes they cover their flax-mat with dog-skin, and that alone we have seen worn as a covering." But, while Cook and Banks and Solander and Anderson are so provokingly concise, Parkinson and the two Forsters are much more profuse and clear.

Sydney Parkinson informs us early, like a true artist noticing the beautiful, that the first natives they saw in six canoes on leaving Poverty Bay "had garments wrapped about them made of a silky flax, each corner being ornamented with a piece of dog-skin." And a little further on in his journal (in narrating that memorable adventure here in our waters of Hawke Bay, in which the New Zealanders kidnapped Tupaea's lad, Taiota, which circumstance also gave the name to our southern cape), Parkinson says:—"An old man who sat in the stern" (of that kidnapping canoe) "had on a garment of some beast's skin, with long hair, dark brown and white border, which we would have purchased but they were not willing to part with anything." And again, shortly after, while at Mercury Bay,

* 2 vols. 4to., London, 1786.

he says:—"In one of the canoes (which came from some distance to the ship) there was a very handsome young man, of whom I bought some things; he seemed by the variety of his garments, which he sold one after another till he had but one left, to be a person of distinction among them; his last garment was an upper one, made of white and black dog-skin, which one of the lieutenants would have purchased, and offered him a large piece of cloth for it, which he swung down the stern by a rope into the canoe; but as soon as the young man had taken it, his companions paddled away as fast as possible, shouting and brandishing their weapons as if they had made a great prize; and, being ignorant of the power of our weapons, thought to have carried it off securely; but a musket was fired at them from the stern of the ship; the young man fell down immediately, and, it is probable, was mortally wounded, as we did not see him rise again. What a severe punishment of a crime committed, perhaps, ignorantly! The name of this unfortunate young man, we afterwards learned, was Te Riunui." So again, while at the Bay of Islands (their next anchorage), he says:—"A canoe came into the bay that had eighty people in her, most of whom paddled; the chiefs wore garments of dog-skins, and were very much tattooed. * * * We saw many plantations of the kumera, and some of the aute, or cloth trees" (*Morus papyriferus*). And in the fifteenth plate of his journal he gives "a New Zealand warrior in his proper dress;" in which his clothing-mat is a fine one, made of cloth woven from New Zealand flax (*Phormium*) within, and with the skins of black and white dogs alternately placed, chequer-fashion, without. Also, in Plate XVIII., the chiefs in the war-canoe are represented as so dressed; and in that ever admirable plate of a war canoe fully manned, with rowers paddling* (also taken by our artist), the chiefs are dressed in similar garments.

G. Forster, writing of the New Zealanders whom he saw at Queen Charlotte Sound (in Cook Straits), says:—"The form and colour of these people was almost entirely the same as that of the Dusky Bay people; their dress was likewise made in the same manner of the flax-plant, but never interwoven with feathers, in lieu of which they had bits of dog-skin at the four corners of their cloaks, which the others were not fortunate enough to possess." Again he says:—"They sold us an apron, made of their close-wrought cloth, covered with red feathers, faced with white dog-skin, and ornamented with pieces of the ear-shell, which is said to be worn by the women in their dances." And, shortly afterwards, speaking of a large canoe of strangers which came up to the ship, he says:—"Two people of a fine stature, one at the stern and another about the middle of the canoe, stood upright; the former had a perfect black cloak of the close-wrought

* Cook's Voyages: first voyage, vol. III., Plate XVI.

kind, patched in compartments with dog-skin. * * * Among their dresses were several cloaks entirely lined with dog-skin, upon which they set a high value, and which indeed gave them a very comfortable appearance in the cold weather that now began to be felt." And six months after, on their return to New Zealand from the Society and other islands, having made Cape Kidnappers and passed it, and when near to Black Head, their ship was visited and boarded by a chief* from the shore in his canoe; to him Captain Cook gave some pigs, fowls, and garden seeds; and the chief, in return, gave to Captain Cook "his *maipi*, or battle-axe,† which was perfectly new, its head well carved, and ornamented with red parrot's feathers and white dog's hair."

J. R. Forster, in his "Observations," also observes:—"The New Zealanders employ the skins of dogs for their clothes, but merely for convenience, namely, to keep them warm. They also make use of their hair in various ornaments, especially to fringe their breast-plates in the Society Isles, and to face or even line the whole garment at New Zealand."‡

It appears, therefore, from the united testimony of the first visitors to this country that the ancient New Zealand dog was much like those of Tahiti and other South Sea isles—that it was merely a domestic animal, small in size, with pointed nose, prick ears, and very little eyes; that it was dull, stupid, and ugly; that it was of various colours, white, black, brown, and parti-coloured, with lank long hair, and a short bushy tail; that it was fed on fish and refuse offal, and that it was quiet, lazy, and sullen, had little or no scent, and had no proper bark. Further, that its flesh was used by the New Zealanders for food, its skin for clothing, and its hair (particularly the long white hair of the tail) for ornamental purposes. And Captain Cook incidentally remarks on the great attachment of the New Zealanders to their dogs; for, in speaking of a native chief whom he had known, a father giving him his son to go away with him in his ship, he says:—"When about to sail, a boy of about ten years of age, named Kokoa, was presented to me by his own father, who I believe would have parted with his dog with far less indifference."§

It seems certain that the variety of dog found by them in New Zealand

* This chief, of whom a portrait is given in Cook's Voyages, I have ascertained to be Tuanui, the ancestor of the present Henare Matua, of Porangahau, so well known among us. Tuanui put off from Poureerere, and Cook's gifts to him were well remembered and circumstantially related. From some of those "garden seeds" sprang the "Maori cabbage" of the coast, which, thirty years ago, grew very thickly there and on to Palliser Bay, and often served me, when travelling, for breakfast.

† Much like that one of mine, mentioned above, p. 135.

‡ Observations, pp. 189, 208.

§ G. Forster also remarks on it, *ante*.

was considered to be greatly inferior to those of the same breed they had seen in the other isles of the South Sea. It is not at all unlikely that this variety had degenerated through successive breeding-in-and-in,* and want of proper food. And it does not seem to have been eaten by our early voyagers, as the dogs of the other islands were, although, for want of fresh provisions, they scrupled not to eat rats and other "small gear." It is true that we have in their journals especial mention of four dogs having been killed for food at different times on board of their ship after leaving New Zealand; but all these it seems were obtained from other places. The dog on which the officers made such a feast when near the Traps off the South Cape of New Zealand, during their first voyage, and shortly after leaving this country, had been "bred on board." The dog which was killed on board for food in June, 1773, during their second voyage and soon after their leaving Cook Straits for Tahiti, was of the "Dutch" breed; † and very likely brought with them from the Cape of Good Hope. Again, after leaving New Zealand the third time on discovery, the dog which was killed on board when near Easter Island, to save Captain Cook's life, was an old ship dog, of which circumstance Captain Cook himself says,—"I was now taken violently ill so as to be confined to my bed, and it was several days before the most dangerous symptoms of my disorder were removed. * * When I began to recover, a favourite dog of Mr. Forster fell a sacrifice to my tender stomach. We had no other fresh meat whatever on board; and I could eat of this flesh, as well as broth made of it, when I could taste nothing else. Thus I received nourishment and strength from food which would have made most people in Europe sick, so true it is that necessity is governed by no law." And about a month after, when on their run from Easter Island to the Marquesas, another dog, which was also killed on board under similar circumstances, was from the Friendly Islands the year before. Of this dog G. Forster writes:—"Captain Cook himself was obliged

* NOTE.—To a superficial observer such must have been much the same in the tropical islands, but there is this great difference, viz., the New Zealanders were, from the earliest times, split up into small tribes, who were ever at deadly enmity; hence the circle of breeding a strictly domestic animal must have been very contracted and limited: it was not so in the islands, which were under kingly rule.

† For this I am indebted to Dr. Sparrman, whose entry in his Journal is so highly characteristic, that I copy it. He says,—"On the 7th June we sailed from New Zealand. * * * After we had been at sea a few days we resolved upon killing a fat, though ugly Dutch dog, before the scurvy, together with the short commons of the ship, should render his flesh unfit for eating. Already used in our run between the Cape and New Zealand to put up with sheep that had died of the scurvy or other disorders, diseased hens and geese, we certainly were not now in a condition to turn up our noses at a roasted dog, which was really very palatable and well tasted." Sparrman's Voyage, 4to., London, 1786, p. 88.

to keep his bed again, being afflicted with some alarming symptoms. * * My father ordered his Tahitian dog, the only one which still remained alive after our departure from the Friendly Islands, to be killed; it was cut into quarters which were served up to Captain Cook during several days, and gave him some nourishment, as he could not venture to taste the ship's provisions. By such small helps we succeeded in preserving a life upon which the success of the voyage in a great measure depended."

They succeeded, however, in taking alive to England one of the South Sea dogs on their return from their second voyage. And this dog had been a peculiar sufferer, for he (with others) had eaten of some very poisonous fish while in the tropics, and, after severe and long suffering, had nearly died; and he had also been repeatedly operated on, by inserting in his flesh poison scraped from the points of the poisoned arrows of the islanders, and yet he got over all! "and was brought alive to England"—the first and only one of his race!

I have already said, that at some of the Polynesian Islands, our early voyagers found no dogs. J. R. Forster says:—"In all the low islands they have dogs (a race with long white hair), but no hogs; at the Friendly Islands, and at Tanna (New Hebrides), they had hogs but no dogs; at the Marquesas, also, they had hogs but no dogs; while at New Caledonia they had neither hogs nor dogs. We gave at Amsterdam (Tongatapu) and at Tanna the first dogs; at New Zealand the first hogs and fowls; and at New Caledonia we left a couple of dogs, and another of pigs. They must formerly have had dogs at Amsterdam, because they knew the animal and were acquainted with its name, *kuri*, but have lost the species, as it should seem, by some accident." G. Forster's graphic description of this introduction of the dog at Tongatapu is worthy of notice. He says:—"Early the next morning Capt. Cook's friend, Ataka (the principal chief of the islands) came on board in one of the first canoes and breakfasted with us. * * * After breakfast the captains and my father prepared to return to the shore with him; but just as he was going out of the cabin he happened to see a Tahitian dog running about the deck; at this sight he could not conceal his joy, but clapped his hands on his breast, and, turning to the captain, repeated the word *kuri* near twenty times. We were much surprised to hear that he knew the name of an animal which did not exist in his country, and made him a present of one of each sex, with which he went on shore in an ecstasy of joy. That the name of dogs should be familiar with a people who are not possessed of them seems to prove either that this knowledge has been propagated by tradition from their ancestors, who migrated hither from other islands and the continent, or that they have had dogs upon their island of which the race, by some accident, is

become extinct; or, lastly, that they still have an intercourse with other islands where these animals exist."

G. Forster also says of the natives of Mallicollo (one of the New Hebrides group):—"Hogs and common poultry are their domestic animals, to which we have added dogs by selling them a pair of puppies brought from the Society Islands. They received them with strong signs of extreme satisfaction; but as they called them hogs *(puaha)*, we were convinced that they were entirely new to them."

And Capt. Cook, in his third voyage, states that at the island of Mangaia which he discovered they had no such animals as hogs and dogs—both which, however, they had heard of. This information he obtained from Mourua, a chief of that island, who visited his ship and conversed on board with the Tahitian native Omai, who was now returning to his own country from England in Cook's ship. Another interesting item Cook relates concerning this chief. He says:—"As soon as Mourua got out of the cabin, he happened to stumble over one of the goats. His curiosity now overcoming his fear, he stopped, looked at it, and asked Omai what bird this was, and not receiving an immediate answer from him, he repeated the question to some of the people upon deck." And a few days after, at the next island, Atiu, which Cook also discovered and visited, he found that they had hogs but no dogs, though they knew the name of it, and "were very desirous of obtaining a dog, of which animal this island could not boast, though its inhabitants knew that the race existed in other islands of their ocean." Of the people of this island Cook further says:—"Our visitors were conducted all over the ship. * * * They were afraid to come near the cows and horses; nor did they form the least conception of their nature. But the sheep and goats did not surpass the limits of their ideas, for they gave us to understand that they knew them to be birds. * * * The next day, soon after daybreak, we observed some canoes coming off to the ships, and one of them directed its course to the 'Resolution' (Cook's own ship). In it was a hog, with some plantains and cocoa-nuts, for which the people who brought them demanded a dog from us, and refused every other thing that we offered in exchange. One of our gentlemen on board happened to have a dog and a bitch, which were great nuisances in the ship, and might have been disposed of on this occasion for a purpose of real utility, by propagating a race of so useful an animal in this island. But their owner had no such views in making them the companions of his voyage. However, to gratify these people, Omai parted with a favourite dog he had brought from England, and with this acquisition they departed highly satisfied."

It remains for me to show what I have been able to glean from the old New Zealanders, during the course of many years' residence and enquiry, concerning their ancient dog, now a creature of the past, equally so with the *moa* and the *kiore*, or New Zealand rat.

From the reliable old natives I gathered that their dog was of small size, and but few in number in a *pa* or village; that it did not bark,* only howled plaintively at times; that it would not bite man; and that rats (the old edible rat) and birds were (in part) its food; that the owners of the dogs were greatly attached to them, gave them names, and prized and petted them (just as I have known the New Zealanders to do to their pigs and mongrel dogs forty years ago); that some of them were trained to seize ground-birds, such as *wekas* and *kiwis*, for their masters, and this was effected in great part through stratagem on the part of the native, who, when he went a bird-catching, would take his dog with him, always leading him securely tied by a cord, and, squatting down concealed in a fit place, held his dog, and imitating the cry of the bird he was in quest of, the bird came near, when the little dog was let go, and he ran and seized the bird, and held it or brought it to his master. Sometimes they lost their dogs, owing to its stupidity or laziness; but the true New Zealand dog never became wild in the woods. Sometimes they were stolen or killed, which of course always led to reprisals, and not unfrequently to murder and to war. Their loss or untimely death was lamented in songs and monodies, of which several are still extant. The white-haired dogs were greatly prized, especially if they had long-haired tails. Such were indeed objects of envy, and were fitting presents for a king! These dogs were taken the greatest possible care of; they slept in a house on clean mats, so that their precious tails should be kept as white as possible. Their tails were curiously and regularly shaved, and the hair preserved for ornamental use. This operation of shaving its tail was quite unique (and would take some time to describe), and was never performed by a common person.

The flesh of the dog was not only deemed a dainty but it was also a *tapu* (or sacred) dish. A dog was always killed for the priest to eat on performing certain *tapu* or religious ceremonies over the children of chiefs, and on other great and formal occasions; also as food for the *tohunga-taa-moko*, or tattooer, when operating on chiefs. Hence, as a large number were continually needed to meet these requirements, the increase was kept under. The skins, when flayed, were cleaned and stretched in a hollow frame, and then hung up in the wind to dry gradually, protected from the sun, rain,

* The New Zealander has different words to describe the cry of the old and of the new or more recent dog. The former is called and written *ao ao*, and *au au;* the latter, *tau tau*, and sometimes *huru*, and *pahu pahu*.

and dew. Men attended to this duty, and also made the dog-skin garments, though the women wove the inner flax-cloth lining. Forster and others, as we have seen, always speak of the dog-skin as the lining of the men's clothing mats, or dresses; such, however, was not the case; they, at sea in their canoes, merely changed sides to them to keep off the saltwater; in fact these dog-skin dresses were manufactured reversible. Many a dog-skin mat has been made within the last fifty years of the skins of dogs of the small mongrel breed, before European clothing became common among the natives. Of these I have often seen the manufacture. I remember receiving an interesting account from an intelligent old native of the killing of one of those ancient dogs, and this was the last one I ever heard of. According to my informant it must have occurred about the year 1831-32 (as he lived with me in 1835,) and took place at Mangakahia on the river Wairoa, (which runs into Kaipara harbour) in the interior of the North Island. A great lady of that place had her chin, etc., tattooed after the old custom, and a dog was accordingly sought as *tapu* (sacred) food for the *tohunga*, or operator. There was but this one left in that neighbourhood, and it was almost taken by force from its owner (a petty chief) who cried and mourned greatly over his dog. My informant also partook of its flesh, being an assistant in the ceremonies. He, moreover, had also travelled extensively in this North Island, but had never seen another true New Zealand dog!

I am aware that Dr. Hector (speaking of those two dog-skins*) says that "they were recognised by some old natives as the skins of the genuine *kuri*, or ancient Maori dog." This native testimony, however, has little weight with me, *i.e.*, in the way indicated by Dr. Hector, and that for several reasons: 1st. I doubt very much if those old natives had ever seen the genuine ancient Maori dog. 2nd. Their meaning (when speaking of those skins as that of a *kuri Maori*) may be very different from what Dr. Hector supposes. As I take it, the meaning there of the adjective *Maori* is very likely to be common and not indigenous, just what any common (plentiful) or cur-like mongrel dog would now be called by the natives, and which, indeed, we hear every day; *e.g.*, as when a native says (speaking of pigs), "*he poaka Maori tonu koa!*" or of peaches, "*he pititi Maori;*" or of potatoes, "*he taewa Maori ano;*" or of guns (muskets), "*he pu Maori;*" or of vessels, "*he kaipuke Maori;*" he means only such as are of the common run or sort—ordinary, general, well-known; of course (in these cases) he never means indigenous or purely native. 3rd. Natives, for several years, have made great mistakes in speaking of animals or plants, especially of those which have become extinct or nearly so, or which have not been seen by them for many years. About four years ago, a gentleman

* Vide ante.

shot a bird in Hawke Bay; he showed it to the old natives around him, who all said it was a native bird; some said positively it was a *koreke* (a New Zealand quail); others, a *mohokura*, or a *mohopatahi* (two species of small rails). However, it was sent to me, and it proved to be the introduced Californian quail. I have long ago known that in all such matters the natives are not now to be depended on;* the oldest ones from their not having seen the animal or plant (in question) for many years, or perhaps not all; the younger ones from their never having known it!

The dog is mentioned in their oldest traditions and myths. Dogs were sometimes sacrificed, in the earliest times, to obtain the favour of the gods who were invoked; notably so, as is circumstantially related in the legend of the migration hither of the chief Turi and his party, who came from Hawaiki in the canoe Aotea, and landed on the west coast of this island. Turi is the (claimed) ancestor of the Whanganui tribes, and when on their voyage they had landed on a small island to refit and repair, a dog, whose name was Tangakakariki, was sacrificed with great formalities to appease the gods and to obtain them favourable winds. And this ancient Polynesian rite of sacrificing the dog may serve to explain two things respecting it which I have not yet referred to; the one took place at Tahiti, when Capt. Wallis, who discovered the island (two years before Cook visited it), was there; and it is thus related by him—but I should first mention that Captain Wallis was obliged to have two desperate engagements with the natives on his arrival, who courageously attacked his ship in great numbers; and it was only after killing several of them, and "landing and destroying more than fifty canoes, many of which were sixty feet long," that they gave over, and peace was made. Captain Wallis says:—"At 2 p.m. (on the day of the last fight) about ten of the natives came out of the wood with green boughs in their hands, which they stuck up near the sea-side and retired. After this they brought several hogs with their legs tied, * * * and some dogs with their fore-legs tied over their heads, * * * also several bundles of cloth, and placing them on the beach called to us on board to take them away. At first we could not perfectly discover of what this peace-offering consisted. We guessed at the hogs and the cloth, but seeing the dogs, with their fore-legs appearing over the hinder part of the neck, rise up several times and run a little way in an erect posture, we took them for some strange unknown animal, and were very impatient to have a nearer view of them. The boat was therefore sent on shore; our people

* Hence the many errors in Maori names of plants, etc., given in the "New Zealand Institute Transactions" *(passim)* and in other modern publications, which seem to have been collected by any and everybody and set down at random, and so doing positive and lasting injury!

brought off the hogs, but the dogs were turned loose, and with the cloth left behind. In return for the hogs, our people left some hatchets, nails, and other things, making signs to some of the Indians who were in sight to take them away with their cloth. After the boat had returned on board, the Indians brought down two more hogs, and called us to fetch them; the boat, therefore, returned and fetched off the two hogs, but still left the cloth, though the Indians made signs that we should take it. Our people reported that they had not touched any of the things they had left upon the beach for them, and somebody suggesting that they would not take our offering because we had not accepted their cloth, I gave orders that it should be fetched away. The event proved that the conjecture was true, for the moment the boat had taken the cloth on board, the Indians came down, and, with every possible demonstration of joy, carried away all I had sent them into the woods."* Captain Wallis remained there at anchor more than a month after this, on the best possible terms with the natives, buying largely of provisions but no dogs, of which animal he scarcely again writes. And Captain Cook (whom I have quoted †) states that after their great falling-out with that people, the chief lady (Operea), in sending him the present by way of reconciliation, included in it a dog—which is also the first time Cook mentions the animal.

The other circumstance I have alluded to is mentioned by Mr. Banks in Cook's first voyage to Tahiti, who saw within the sacred *marae* (or paved court of their great temple) "several small stages which seemed to be a kind of altar, as upon these are placed provisions of all kinds as offerings to their gods * * * and we found here the skulls of above fifty hogs, besides the skulls of a great number of dogs."

And while such sacrifices were rare, if not unknown, in New Zealand (where hogs were not and dogs but few), still we may see a remnant of them in a dog having always to be killed on great ceremonial observances as a sacred food for the officiating priest or *tohunga*.

A few named dogs take a prominent place in the very dawnings of history among the New Zealanders—before they even left Hawaiki—whether that place be a reality or a myth. It is related in their earliest legends that a dog belonging to a great chief named Houmaitawhiti, who lived at Hawaiki, having committed some trifling error, was killed and eaten by another chief of that place named Toitehuatahi. On the dog, whose name was Potakatawhiti, being missed by its owner, his sons went seeking the animal in the several villages in the neighbourhood, calling it, in their way, "*Moï, moï.*" On their seeking it in the *pa* of Toitehuatahi, the dog, hearing their call, responded from within the stomach of Toi, "*Au,*

* Cook's Voyages: first voyage, vol. I., p. 451. † Vide ante.

au," although the enraged chief kept his own hand tightly on his mouth, so that the dog's cry should not be heard by that outlet. The young men, however, hearing it, returned to their father and told him of it, and soon reprisals began, and a desolating war followed, which ended in a migration to New Zealand!

Another famed dog was in the canoe of another lot of emigrants from Hawaiki, led by the chief Manaia. On its way to New Zealand, the dog, scenting the land before it could be seen, and a dead whale that had been cast on shore, sprang overboard, and swam howling towards the land; the canoe followed all that evening and night, guided only by the cries of the dog, and so not only reached the land in safety, but also came in for a feast on the stranded whale,—and more good things afterwards.

Another strange dog legend is told of Irawaru, who was brother-in-law to the famed demigod Maui—the hero who, among several other equally strange adventures, fished up the North Island of New Zealand, and caused the sun to travel more reasonably through space for the benefit of man. The story is too long to relate here, but I may just say that Irawaru had displeased Maui, who, getting him unsuspectingly into his power, pulled his ears upwards and his back-bone out, so as to form a tail, and then transformed him into a dog! Cruelly sending his sister, on her enquiring after her husband in the evening, in ignorance of what had happened, to call him by the usual dog-call of "*Moï, moï,*" which the poor newly-metamorphosed dog plaintively answered; on which the wife committed suicide by throwing herself into the sea. Hence, it is that Irawaru is said to be the father or precursor of all dogs.

In conclusion, I will merely add that it is my conviction that, hereafter, several of these things I have here brought forward will prove to be of service, trifling as some of them may at first sight appear to be, for, apart from the few concluding myths and legends, they are all facts. Facts, realities, respecting the ancient New Zealand dog (we have no more!). And these may tend towards elucidating the origin of the New Zealanders. And let it never be forgotten, particularly by such an institution as ours, that facts, faithfully recorded facts, however small in themselves, are not only stubborn things, but are sure to become useful. Science is still seeking to know of the origin of the New Zealanders, and of their so-called migrations hither; and here, in much of what I have compiled and written and laid before you is food for the reflective mind; indications which may yet prove of service. Further: it has often been thoughtlessly said, that because (in some parts of the north of this island) the dog was also called *pero* and *peropero** by the natives, therefore it was introduced into this country by

* The New Zealanders have several common names for the dog, as *karareha*, *kireha*, *kuri*, *pero*, *peropero*, *pape*, and *moi*—though this last word is more properly the call for a dog.

the Spaniards! (*perro* being the Spanish word for dog). Here, I think, will be found quite enough to upset that far-fetched theory, seeing that the New Zealanders possessed their little South Sea dog ages before a Spanish keel ever floated on the waters of the South Pacific! But there are several other such theories abroad, equally without reasonable foundation.

ART. XI.—*A System of Weights and Measures.*

By J. CARRUTHERS, M. Inst. C.E.

[*Read before the Wellington Philosophical Society, 1st September,* 1877.]

IN designing a system of weights and measures there are several points to be taken into consideration, of which the most important is, perhaps, that the radix of the system shall be continually divisible by two without a remainder. The number of inches, for instance, which the foot contains or the number of shillings which the pound contains should be some power of two. An odd number would be most inconvenient as the radix. If the foot contained eleven inches, half a foot would contain $5\frac{1}{2}$ inches, and a fraction is at once introduced, the inconvenience of which in commerce and in all arithmetical and mechanical work is very great.

Next to the odd numbers, the most inconvenient are the odd numbers multiplied by two such as 6, 10, 14, 18, etc. Here the objectionable fraction is put off one step only, and on halving twice again shows itself.

No system of measures in which one of these numbers is adopted as the radix ever has been nor ever will be thoroughly in use. The American divides his dollar into half and quarter dollars, and to continue as far as he can the convenience of being able to divide by two he adopts the "bit" or "York shilling" unknown to the law. The English workman divides the inch, not into three barley-corns as by law directed, but into halves, quarters, eighths, and sixteenths. The French workman again divides his millimetre into halves and quarters like his English brethren. The two systems, in fact, run side by side but do not coalesce; as far as the decimal system lends itself to division by two it is used, but no further. As soon as it fails in this respect it is thrown aside in favour of the more natural and convenient system of having a radix continually divisible by two.

Another important point is that the several measures of weight, superficies, capacity, etc., shall be tied together, and be interdependent. The French adopted a logical system in which this point received full attention, but the inherent unsuitability of the number 10 as a radix has prevented its adoption in full, and their system is now a body without a head, for their

unit of length, although it is a determinate part of the circumference of the earth, bears no simple proportion to a degree of latitude. The English system is a complete chaos, but in fixing the imperial gallon a slight movement in this direction was made, as it was fixed as a vessel which would just contain ten pounds weight of water.

The next point for consideration is that the units shall be of convenient value. All the European nations have adopted a measure of length not very different from the English foot. This may be taken, therefore, as a measure which has been proved by experience to be sufficiently convenient. Considerable latitude is, however, permissible in this matter, and no inconvenience has followed the adoption of the metre which is more than three times as long as the English foot. Whatever value be adopted for the unit it should be as far as possible dependent on some measure given by nature and not liable to change.

The last point and one of the most important of all is, that the radix of measures shall be the same as the radix of counting. This latter all over the world is the number 10. Unfortunately this number is not well suited for the radix of measures, and as long as it is maintained as the radix of counting, we cannot have a perfect system of weights and measures.

We cannot alter the properties of the number 10, but we can depose it from its undeserved eminence as our counting radix, and adopt a more suitable number. If our primitive forefathers had only turned in their thumbs, when using their hands to help them in the difficult process of counting, and had used their eight fingers instead of their ten fingers and thumbs, we should have had 8 for our counting radix—a nearly perfect number, as it is a power of two. They did not do so; but there is no reason why we should be bound by their mistake for ever. We should clearly change the faulty radix we have inherited from them.

The difficulty of changing the counting radix has, however, always been looked upon as too great to attempt, and the scientific world is quietly adopting the French system, knowing it to be imperfect and inconvenient, although less so than any other in use, having nearly all the requirements of a perfect system, except that of having for its radix some power of two. This exception is, however, of sufficient importance to condemn the system. The inherent unsuitability of ten as a radix will become more and more apparent, as commerce, and the arts and sciences take a more important place in daily work. It must sooner or later be set aside for some other number. We are, therefore, only putting off the evil day by adopting the French system, and would much better change the radix at once.

I cannot but think that the difficulty of making the change is very much exaggerated. We have some experience of the ease with which a radix

other than 10 is adopted, as in some of the more trifling affairs of business the dozen has actually supplanted the ten. For instance, eggs are sold by the dozen, and 12 has become the counting radix as far as eggs are concerned. Everyone feels at once the number represented by six dozen eggs; but if 72 eggs are mentioned, the number is instinctively turned into dozens before a clear perception of its value is obtained. If, now, everything were sold by the dozen, and the pound contained a dozen shillings, and all other weights and measures were reckoned in dozens, it would become a very simple thing to count by the gross and dozen instead of by the hundred and the ten. Twelve fails in the necessary requirement that it shall be continually divisible by two without a remainder, and is not therefore suitable for the radix; but, if 16 or 8 were used as a radix of measures, it would after a few months, or at most a few years, be so easy to reckon in sixteens or eights, instead of in tens, and at the same time so convenient, that legislation would not be required to effect the change; it would come of itself by use and habit, just as it has come about that eggs are now reckoned in dozens. Some slight inconvenience might be felt at first, such as is felt in going to a foreign country, where new measures are met with; but everyone who has lived abroad knows how slight this inconvenience is. After a few months the new measures quite supplant the old; and it becomes convenient, in thinking of English measures, to translate them into those which even so short an experience has rendered familiar. It is, in fact, only through pure cowardice to meet a difficulty that the scientific world is taking up the imperfect French system. A far better system, which would never require alteration, might be adopted, if we would only fairly look in the face the difficulty of changing the counting radix; and, like most difficulties, this seems the less the more it is looked at.

Assuming then that the radix must be changed the question arises what number is to supplant ten. It must be a power of two. Two itself and four are too small. Eight has some claims but is also too small. School-boys would all vote for it as they would have to learn the multiplication table only up to 8 times 8 instead of to 10 times 10 as at present, but the inconveniences of having so small a radix are too great and a larger must be sought. Thirty-two on the other hand is too large. The average mathematical mind would not be able to work a multiplication table extending to 32 times 32, and a loss of convenience would accrue. Half-way between these two would be about right, that is 16 should be the radix. The multiplication table would not be unwieldily large and the figures required to express a large number would not be too numerous. The present radix 10 is certainly smaller than is desirable, and 16 would be an improvement from every point of view.

Our radix being thus established we must next establish our unit of length on which all the others depend. The earth is our best natural measure, and our standard sea-mile should represent a definite angle measured on its surface, as our present sea-mile or knot does. All commercial nations, including the French, have been driven to adopt this measure for the purposes of navigation, although in no case does it correspond with any measure used on the land. The increasing importance of commerce makes it very desirable that the land-mile and the sea-mile should be the same. This brings us to angular measurement as the foundation of the whole system.

The French saw the absurdity of dividing the circle into ten equal parts, so they divided it into four right angles, and then divided each right angle into ten parts. On this division of the earth's circumference they founded their measures of length. Unfortunately the circle is not to be influenced by Acts of Parliament or of Senate. It is by its very nature divided not only into four right angles but also into six sections of equal importance to the right angle, and any system of angular measure which ignores this fact must break down. The French system ignored it so completely that the important angle of 60° cannot even be expressed in figures. It consequently broke down completely; it never had the least chance of coming into use and is now seldom heard of.

It is essential that the division of the circle shall be such that the right angle, and the arc of which the chord is equal to radius, shall both be expressed by convenient numbers. If the arc of 60° be divided into 16 equal parts, 24 of such parts would represent the right angle, and this would, with the radix of 16, be the best division possible. On this system the earth's circumference would be divided into 6 equal parts, which we may call radius arcs; each of those would be divided into 16 points, each point into 16 degrees, and each degree into 16 sea-miles. The circle would be divided in the same manner, and the sea-mile would represent a measure of latitude corresponding to a second of the present measures. The new sea-mile would be a little longer than the present statute mile, and somewhat shorter than the present sea-mile or knot; it would be 5,850 feet long, while the statute mile contains 5,280 feet. Of course the mile would be further sub-divided, always into sixteens, which would give us the ell equal to about 16 inches; and the inch, which would differ only about 2 per cent. from the inch as we now have it.

Measures of weight follow from those of length. A cubic ell of water would weigh 187lbs., and would be the standard. Larger or smaller measures would be obtained by multiplying or dividing by 16, as might be required.

The cubic ell and superficial ell would be the fundamental measures of capacity and area.

Measurement of time is only a form of circular measurement, and the day should be divided, like the circle, into six watches of four hours each; the watch would be divided into sixteen parts, each exactly equal to a quarter of an hour; and the quarter-hour into sixteen minutes, instead of fifteen as at present.

I need not further recite the different measures to be used, as I affix a table showing their value in ordinary English measures.

Of course fifteen new figures would have to be designed to use with the sixteen-fold system of counting, as the present figures would have to be kept exclusively for the decimal system. In the tables I have used the letters of the alphabet instead of the new figures.

The system I have sketched out would have all the advantages of the decimal system and none of its disadvantages. It would be coherent throughout, and would greatly reduce the labour required in all arithmetical processes arising in business and science. There would be a loss of money in making the change, as a large amount of capital has been invested in machinery which has been designed for sub-dividing the inch in England, and the corresponding measure in other countries. As far as England, Russia, and America are concerned, this might be saved by a small sacrifice of the completeness of the system. By taking the inch as the standard, and multiplying by sixteen for the higher measures, we should get a mile which would be about 2 per cent. shorter than the sea-mile.

Table of Measures.

Notation. Decimal System.	Notation. Sixteen-fold System.	Name.	Remarks.
Time Measure.			
1	A	Day	1 Day equal 24 hours
6	F	Watch	1 Watch ,, 4 ,,
96	FO	,,	1 ,, ,, ¼ ,,
1536	FOO	,,	1 ,, ,, 15/16 minute
Circular Measure.			
1	A	Circle	1 Circle equal 360 degrees
6	F	Radius arcs	1 Radius arc ,, 60 ,,
96	FO	,,	1 ,, ,, ,, 4 ,,
1536	FOO	,,	1 ,, ,, ,, 15 minutes
4,096	F,OOO	,,	1 ,, ,, ,, 15/16 ,,
Long Measure.			
1	A	Sea-mile	1 Sea mile equal to 5,350 feet
16	AO	,,	1 ,, ,, 335 ,,
256	AOO	,,	1 ,, ,, 21 ,,
4,096	A,OOO	Ells	1 Ell ,, 1·3 ,,
65,536	AO,OOO	,,	1 ,, ,, 0·98 inch
1,048,576	AOO,OOO	,,	1 ,, ,, 1/16 ,,
Superficial Measure.			
1	A	Square mile	1 Square mile equal 688 acres
16	AO	,,	1 ,, ,, 43 ,,
256	AOO	,,	1 ,, ,, 2⅔ ,,
4,096	A,OOO	,,	1 ,, ,, ⅙ ,,
65,536	AO,OOO	,,	1 ,, ,, 453 sq. feet
1,048,576	AOO,OOO	,,	1 ,, ,, 28 ,, ,,
16,777,216	A,OOO,OOO	Square ells	1 Square ell ,, 1·8 ,, ,,
Solid Measure.			
1	A	Cube	1 Cube equal 35 cubic feet
16	AO	Cubic ells	1 Cubic ell ,, 2·2 ,,
256	AOO	New gallons	1 New gallon ,, ⅞ gallon
4,096	A,OOO	,,	1 ,, ,, ⅕ pint
Weights.			
1	A	Load	1 Load equal 2,197 lbs.
16	AO	Water ells	1 Water ell ,, 137 ,,
256	AOO	,,	1 ,, ,, 8·6 ,,
4,096	A,OOO	,,	1 ,, ,, ½ ,,
65,536	AO,OOO	Water inch	1 Water inch ,, ½ oz.

Art. XII.—*Notes on blowing up Snags in the Waikato River with Dynamite.*
By R. R. Hunt.
Plate III.

[*Read before the Auckland Institute, 22nd October*, 1877.]

The channels through the pumice sand in the "sunken forest" near Rangiriri, Waikato river, are constantly shifting and thus often expose new "snags" or the remains of trees, which are very dangerous to steamers and barges plying on the river; as a proof of which may be mentioned the fact, that three steamers and many barges of the Waikato Steam Navigation Company have been snagged and sunk by them; this company (of which the writer is manager) whenever dangerous snags appear, blows them out with dynamite, and a few remarks on their experience may not prove uninteresting.

First selecting a snag to be removed, a boat is moored above stream of it and athwart the current, by anchors, bow and stern; these steady her in a breeze, and by their help the boat can be pulled up stream when the fuse is fired, and after the explosion she can by them be dropped back into exactly the same position as she had previously occupied; this being important as it sometimes happens that a second shot is required, and no one who has not tried can imagine how difficult it is to find the same snag or spot in running water after you have left it unmarked.

Now, supposing the boat to be in position, the next thing to be done is to carefully view the snag with a sub-aqueous telescope (if it may be so named) made as per sketch (Plate III.).

A hole is then bored down the stump with an inch-and-a-half auger to three feet six inches below low summer level, that depth permitting the steamers to pass over safely.

Some dynamite and a cartridge previously prepared are then placed in the hole, the fuse fired, and the boat hauled away about fifty feet, a perfectly safe distance; soon the explosion is heard, and then, usually, the snag is a thing of the past. All this seems simple, but it is easier talked of than done.

The cartridge is made up watertight simply to prevent the cap getting wet, water does not injure dynamite in the least. The sketch will show the fuse (that coated with rubber is the best) inserted in the cap, which is about an inch long, the cap is buried in the ignition charge, this being a particular kind of dynamite, the charge is connected with one of the ordinary 2½oz. packets of dynamite, these are then wrapped in common calico, tied tightly with string, and dipped into melted tallow or pitch to render the whole waterproof; attach this cartridge to a slight stick, long enough to reach from the

bottom of the bore-hole to above water, the fuse being fastened to it. The cartridge is then complete. Care must be taken that the diameter of the stick and cartridge together do not exceed one inch, else if the hole has not been bored perfectly straight, or if any roughness is left in its sides, the cartridge may not go home, and only the top of the snag will be blown away. The water is sufficient tamping for dynamite.

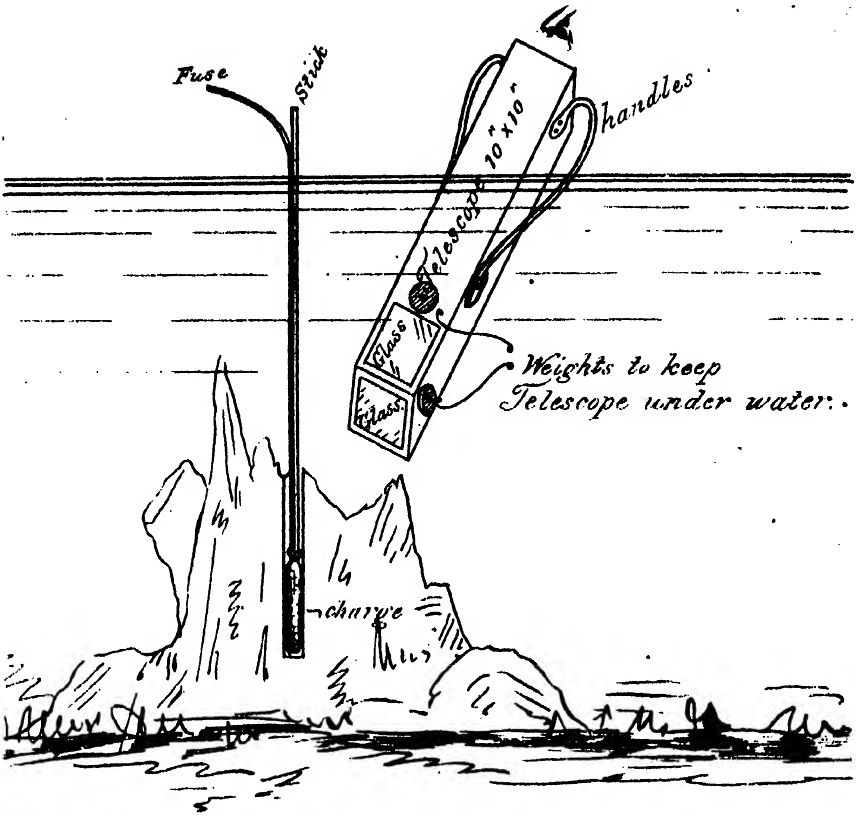
The hole is bored with an inch-and-a-half shell auger, that kind being found superior to American or others, as it cleared itself of the borings better than they did. The hole is bored down to the depth at which it is desired to cut off the snag.

The sub-aqueous telescope, or instrument for viewing the snags under water, is indispensable; without it much valuable time would be wasted; it is difficult to see objects clearly under water even under the favourable circumstances of a clear sunshiny day and the surface of the river smooth, and it becomes impossible to do so with a slight ripple on it, which is its usual condition. It is necessary to bore into solid wood, some of the snags are rotten at the sides, and a charge exploded there is wasted; with the telescope you can see exactly where to bore, the amount of dynamite required, and the work can proceed uninterruptedly.

The charge of dynamite used varied with the size of the snag—from 5oz. to 24oz. were tried; the average charge was 8oz. It was found to be false economy to use too little, as the explosion then only shattered the stump, and it took double or treble the quantity next shot to clear it away entirely. About half-a-pound was sufficient for a stump two feet in diameter. The workmen judged how many packets of dynamite to place in the hole according to size of the snag, and upon these the cartridge was placed. Though each packet is wrapped in thick paper, they all explode instantaneously.

The snag which sunk the p.s. "Quickstep" was four feet diameter. The men revenged her by placing one pound and a-half of dynamite in it. After the explosion not a vestige of it could be found.

Effects of the Explosion.—The action of dynamite on the snags is peculiar; it invariably cuts them off at the bottom of the auger-hole, leaving a flat surface on the remaining part of the stump, as if a cross-cut saw had done it. One new pile which was desired out of the way, was cut off at the water's edge, then bored as usual, and after the explosion the part from the bottom of the auger-hole upwards floated to the surface with the hole still through it, and bearing signs as if another saw had been at work below water cross-cutting it. The whole of the snags operated upon were upright stumps of trees, with one exception. This was a log resting horizontally, out of water. The men hoped to split it up, and bored a hole in the middle



Stick to be tapered towards end for about 12"

A *Calico wrapper coated with tallow.*
B *Ignition charge.*
C *Dynamite charge.*
E *Stick.*
F *Fuse.*
D *Ignition cap.*

BLOWING UP SNAGS.

To illustrate Paper by R. Hunt.

R. Hunt del.

of the log to its centre. Then the same cross-cutting action was seen; it did not split the log, but cut it nearly in half, as if it had been done with a gouge; and a second shot in the same place showed a like result. Then they found an old split in the end of the log; a charge in this simply laid it open along the line of the old cleavage. Some few of the snags evidenced a downward force from the explosion, disappearing entirely; the only thing remaining to show where they had been being air-bubbles rising from the sandy river-bed at the spot. One hollow snag, three feet diameter and the same deep, with a shell only two to three inches thick, showed this downward force well. Many charges had been tried in the shell, but without much effect, as they did not seem to be able to get a hold of it, merely splintering it. One pound of dynamite was then placed at the bottom of the cavity, and after the explosion an oar was put down the split nine feet! but the old stump stands triumphantly there still. Some people use dynamite for felling trees. The writer is not aware how they apply it, but thinks the observed cross-cutting action should be further experimented upon. If boring a hole from the outside to the centre of a tree, and exploding dynamite therein, does not shatter it for timber, proves expeditious and economical in felling, it would certainly save many lives per annum, as the fuse could be timed to let every one get clear of the tree, and no accidents to bushmen should then be chronicled.

The cost of blowing up snags by dynamite must be trifling as compared with the method followed during the war by the Government of cutting them out with saws. The aforesaid company tried this plan before the writer adopted the dynamite; it then cost them fifteen shillings per snag, with the dynamite about five shillings each. On the average three men are able to blow out eight snags per day.

Names of the wood operated on are (mostly) kauri, matai, and rimu; the latter resisted the dynamite more than the others, taking at least double the quantity to blow them out. The top of the snag which sunk the p.s. "Waipa" is now in the Auckland Museum; it is kauri; when cut off by a diver and brought into contact with the air it split up directly, as you may now see it.

Further experiments will be made on next snagging expedition, with a view to lessening the cost of blowing up snags, by doing away with the boring and making the dynamite do the whole work—viz.: *First*, upon small snags of nine to twelve inches in diameter by encircling the trunk by packets of dynamite like a string of sausages round it to see if it will cut the snag off. *Second*, upon snags of from one to two feet in diameter, to see if exploding the dynamite on the somewhat flat top will remove them. *Third*, to ascertain the effect of a sausage-like string of dynamite exploded

inside of hollow snags. The result of these experiments will probably be sent to you at some future time.

Art. XIII.—*Notes on the firing of Torpedoes by Electricity.* By J. A. Pond.

[*Read before the Auckland Institute, 19th November, 1877.*]

The short note by R. R. Hunt read at the last meeting, relative to destroying snags by dynamitic charges, has led me to bring this subject again before the members, as I believe an alteration in the manner of firing the charges, which was carried out by the fuse, may lead to more comprehensive working in this matter, with more certainty, safety, and economy.

In the first place I would premise that the charges placed for the demolition of the snags are of gunpowder, and so arranged as to be fired by the ordinary fuse: this being so, it simply remains to exchange the latter for an insulated copper wire from a moderately powerful electric or galvanic battery. The wire having been cut, and a few inches of platinum wire inserted, it only remains to enclose this in the powder, place the charge and withdraw; the connection with the battery then being completed, the platinum wire through its inferior conductivity becomes incandescent, and the charge is exploded. When, however, the cartridge is of dynamite, lithofracteur, or nitro-glycerine, it requires the addition of fulminate of mercury to explode it, and this being placed in a small copper tube may be ignited either with platinum wire as before or by the spark; the former, however, is the safer, as any disarrangement of the striking distance might prove fatal to the explosion of the charge.

I need hardly remark that the distance which may be gained from the scene of danger, the security attained, the precision and certainty of the ignition, place this means of firing far before that of the fuse for sub-aqueous explosions. And even on points of economy the firing by electricity will be advantageous, as only a small portion of the insulated wire is injured sufficiently to be valueless for future operations. Another advantage is gained when a number of charges are to be fired simultaneously, as this can be done at one connection of the wires, providing that the charges are not too numerous and too far apart, as in that case, after a few have been exploded the electric current chooses the shorter circuit through the water, caused by the rupture of the wire. When blasting is carried on upon the land or in mines, the value of this manner of firing would be shown chiefly in the reduction of the number of serious accidents caused by the hanging

fire of the fuse and sudden explosion while drilling out or putting in an adjacent shot, through the smouldering fuse suddenly completing the work for which it was intended. One difficulty would be experienced at first in insulating the copper wire with a material that would withstand the heavy blows generally administered in tamping, but when charges of lithofracteur, dynamite, or nitro-glycerine are used in the same places, this difficulty would be obviated by the use of water, mud, or soft material for tamping; and especially in those instances where simultaneous firing is required, the moment of explosion and the number of charges to be dealt with is so completely under control, that I am surprised so little has been done as yet in the more frequent use of electricity for this purpose.

But passing to a more serious consideration of this subject—the firing of torpedoes—I trust I may be excused if I bring before the members of this Institute the extreme and increasing interest taken in this weapon at home and the enormous strides which are being taken, first to bring this arm into use for the defence of ports and the attack upon ships, and secondly to guard, as far as possible, against the disastrous consequences of a successful attack with this weapon. And when we think of the fearful effects caused by the explosion of a well-charged torpedo when placed in its most favourable position for damaging a vessel, and take cognizance of the wonderful powers and varied character of the respective torpedoes, each fraught with the same object, it should do more than interest us, and cause us to enquire in what way these weapons may be of service in the defence of our ports, and whether we have to deal with the Whitehead torpedo, with its complicated and secret machinery, with its evolutions so wonderful that Lord Salisbury lately remarked at a public meeting "that it could do almost anything but talk,"—the Harvey torpedo, which may be towed parallel to the towing vessel and at a long distance from her, and thus be brought to bear in a speedy manner upon the enemy—or the still more deadly, because hidden, torpedo, moored in the track of ships and ready to be fired by the electric wire, it behoves us to examine and, as far as possible, decide in what way we could be guarded from the attack of armed cruisers, who having levelled black mail upon us, would probably return again at another convenient season. With this object I have brought before you the points which I consider should be guarded and the means of so doing, and I may add that when we see the neighbouring colonies taking this matter in hand with the same object, I think we should be up and doing while there is time and not be in the sorrowful position when too late of knowing that

"Of all the sad thoughts of tongue or pen
The saddest are those, it might have been."

Owing to the many entrances to our spacious harbour, it becomes a

serious consideration to guard each place, as beyond the ordinary route through the Rangitoto channel we have the eastern passage on both sides of Moto Ihi, the Waiheke Channel and the sand-spit, but the whole of these converge to a point between Brown Island and Rangitoto, thus practically reducing the points to be guarded to two, and these I will deal with separately. Outside of a line drawn from the reef to the mainland no point can be obtained by which the elevation of a gun could accurately be brought to bear upon Auckland, but inside that line several points come in to view which would prove of value for that purpose, though distant from the city, notably the new hospital, All Saints Church, and Parnell, therefore our first defence must be outside this line, and that will commence from the reef. Here the safe working channel does not exceed three-quarters of a mile, and at this place I would place the first line of torpedoes, inside of which I would have a second, third, and fourth line decreasing in number and coming to an apex, all being connected with the station by insulated wire in the way I will now describe. The safe working channel being about 1,500 yards wide, I would place say 14 torpedoes in the first line, 12 in the second, 8 in the third, and 5 in the fourth, the electric connections being carried to a high station, for instance, the North Head, which is admirably suited for the purpose. If this station was decided upon it would be the only one required for the defence of both entrances, as I will show presently.

On the high cliffs approaching the lake, which reach an elevation of sixty or seventy feet, will be required an observing station with one operator to give the signal to the main station at the North Head, by electric alarum, as to the enemy's approaching the first line of defence, and the same with respect to the second and third. From the main station it would be seen by the use of a theodolite or cross-wired telescope (the position of the torpedoes being accurately known) whether the enemy was sufficiently in position for the firing of the nearest torpedo, if not she would be permitted to come towards the second line, and presuming she had gone midway between the intervals in the first line she would now be approaching exactly to one in the second line, and on the signal being given from the observing station that she was already on that line, and its being seen from the main station that she was over or close to the position of the torpedo, it would simply require the depressing of the electric key to insure the discharge of the torpedo and probable ruin of the vessel.

With respect to the defence of the Eastern passage, I wish to draw attention to the narrowing of the Koreho Channel about 1¼ miles N.E. of the Bean Rocks, or nearly midway between that spot and Brown Island, and also that in the centre of this channel is a very shallow bank of only

$1\frac{3}{4}$ fathoms at low tide, while projecting from Rangitoto is a bank with only $2\frac{1}{4}$ fathoms, giving only 1,400 yards of channel to the bank on the south side, while midway is the shallow bank about 400 yards long, thus reducing the distance to be defended to less than 1,000 yards. It will thus be seen that fewer torpedoes will be required to defend this passage, and the North Head would be directly at right angles to it, thus placing it very favourably for direct observation, while the highland to the west of the Tamaki Heads would prove a favourable position for observation from whence to signal, either by flags, lights or telegraph, the approach of the enemy to the first line of the defence. I would pay especial attention to this passage, as I think it very likely an enemy would choose that, anticipating that the most used channel would be the best guarded. And it must be borne in mind that the days for attack by sailing craft are past, and that, if Auckland was attacked, it would be by several steamers and not one only, as no enemy would do so hazardous a thing as to send in an unpiloted and unattended steamer, as the slightest mishap to vessel or machinery would at such a time place her at the mercy of those she came to molest; nor is it likely that small, light draught cruisers would be chosen for the work, as in the South Pacific there are no naval stations where the attacking squadron would be safe from the British navy then on the station, or where they could provision, coal, or dock, therefore large vessels alone would be enabled to attempt the work, and again a light draught vessel would be unable to carry an armament sufficiently powerful to do any damage at long range.

With respect to the distance of Auckland from the respective outer lines of proposed defence, I find from the Admiralty Chart that the centre of the first line in Rangitoto Channel is 200 yards less than five miles, but this would be reduced to $4\frac{3}{8}$ miles should the vessel stand well in to the bank, still keeping outside the line; this is measured to the lower part of Queen Street, but by his standing in so close it would preclude him from seeing any portion of Auckland district unless from his mast-head, and then the only places which he could observe would be Mount Eden, Mount Hobson, and perhaps one or two other points of the high land, and from this position I do not think we have anything to fear from shot or shell falling into the city, as irrespective of the distance he has no point on which to concentrate his fire, and certainly none on which to observe the effect of his work. But from the Koreho Channel the position is altered, as here he has full view of the town, which he could absolutely rake provided he had artillery which would carry far enough; but the distance from this point to the lower part of Queen Street is five miles and 800 yards, and here again must be borne strongly in mind the fact that guns heavy enough to throw shell

such a distance can only be borne on large vessels, and the draught of these would not permit of such a ship lying at anchor in 3½ fathoms of water at low tide, as the risk of grounding at low water, which she would inevitably do, would be too great, as any injury to her screw or rudder would almost certainly prove fatal to her enterprise. It will be seen from the chart that I have taken this necessity in view all through, and thus only protected the channel, leaving the banks unguarded; if, however, a light draught steamer was to accompany the attacking fleet, she might be sent forward to try and get within range of the city, and this she could only do by running the gauntlet of the defences, or getting over the banks north and south of the Koreho Channel; to prevent this, a few torpedoes could be placed on the banks, and with a few judiciously placed dummies, which being seen would make her cautious how she essayed the attempt, would, I think, be sufficient. One more point and I have finished with this part of my paper. The electrical station which I propose at the North Head would be two miles and 700 yards distant from the outer line of the eastern defence, and 2¾ miles from that in Rangitoto Channel, and from this point a gun battery would be well within range to prevent a small steamer running in, and also to guard the electric wires from any attempt at dragging and grappling them. It might be worthy of consideration as to the advisability of laying a few electric-attached torpedoes, with circuit-closing attachments, by which any vessel coming in would, on contact, close the circuit herself and thus discharge the torpedo directly under her; two of these circuit-closers might be attached, floating just beneath the water at a certain distance on either side and above the torpedo; any ship then touching either would be within striking distance of the charge, and in time of peace the connections of the battery would be broken, or if only a weak current was permitted to flow, the addition of a light, deflecting galvanometer would give notice of a passing vessel during the night.

But the laying these torpedoes as I have proposed is not by any means all that is necessary. What we require first is a volunteer company, to be especially trained to the work. It would not require many men, but they must be of undoubted courage and intelligence; and I think there would be no difficulty in forming such a company of, say, thirty men, which might be attached to the artillery or naval force, but preferably remain intact. They would require to master the knowledge of the different torpedoes and the means of firing them; then, with the addition of a few Harvey, two or three Whitehead, and some spar torpedoes, I think the port might be made thoroughly impregnable. The use of the small steam launch, now so seldom required, might be given to them occasionally, and they would thus make themselves thoroughly acquainted with the positions they had to defend;

and to effectually prepare for the defence, it would only necessitate fixing the anchors or blocks of stone to hold the torpedoes in place, together with a rope reeved through the ring and buoyed, so that in time of danger the torpedo could be attached to its electrical connections, and hauled down into its place.

There are many details which it would be the duty of the company to learn and understand so thoroughly that when needed everything would be in position and free from any fatal hurry. One actual necessity for the completion of this scheme would be, in times of actual danger, the closing of the port between sunset and sunrise, and the establishment of a pilot force for *reconnaissance* before permitting any vessel to enter. Without this the whole plan would be valueless. The closing the Bean Rock lighthouse, and removal of buoys and beacons, would also be advisable.

With respect to the sunken torpedoes, I would have them made in the simplest manner, very similar but much smaller than the iron buoys which mark our coast. The connections would require to be severely tested, and the charge would be of dynamite or lithofracteur, fired by fulminate of mercury. If of dynamite, which would be preferable on account of less danger to the charge from leakage, the cartridge would not need to be more than 50lbs., equal to an explosive force of 800lbs. of powder. I think it would be found more economical to increase the number of torpedoes than the weight of the charges. Dynamite is a material of commerce now, and generally obtainable; but if in case of danger it was found necessary to make it, we have material in the city to make several hundred pounds of nitro-glycerine, and the men to undertake its manufacture, while infusorial earth is obtainable at the distance of a few miles from the city. Fulminate of mercury also could be prepared in a few hours when required.

I have thus shown that the work of defending our port can be done at any moment, and if it were carried out as I have suggested by a volunteer torpedo company it would be but a small expense to the Government, and could go on in fine weather and at leisure; and when it was known that defence became a necessity the completion of the work could be carried out systematically and orderly long before there was any actual need of it, as with the telegraphic communication with Europe we should be in possession of the news in a few hours, while several weeks would elapse before an enemy could put in an appearance. I have now completed my remarks upon the subject of defence by torpedoes, but with your permission will say a few words upon the probability of landing being effected.

I do not anticipate any danger from this, as it is unlikely so large a squadron would be despatched to such a distance as to enable them to land a sufficient body of men to prove a source of real danger; but, presuming

such to be the case, we have a marked satisfaction in knowing that no part of the colony is so favourably placed as we are in this respect, as in addition to the companies now forming our volunteer force there are a large number of men who have had to learn how to defend their homes in years gone by, and these I feel sure could largely be counted on as a defence force at a few hours' notice. If the enemy came by Rangitoto Channel they could only land in the vicinity of the lake where Auckland would not be threatened, and a capital defence of the isthmus of the North Shore could be made. If, on the other hand, they came through the eastern passage, they would probably push up the Tamaki and strike the Panmure road. With the defence now to be made I have nothing to do, except to point out the number of small steamers we have in the harbour which could carry a large body of armed men to any point threatened within an hour.

In conclusion, I do not lay claim to any original work except adapting the ways already known to our harbour. In this also I have to acknowledge with thanks much information from Captain Burgess, harbour master, and for the plan of laying the torpedoes to A. H. Atteridge, in a paper to the *Popular Science Review*, 1873.

Art. XIV.—*Experiments on the Lifting Power of Inclined Planes in Aerial Transit.* By Henry Skey.

Plate IV.

[*Read before the Otago Institute, 9th October,* 1877.]

One of the great difficulties in aeronautics is the steering the apparatus if a balloon be employed, and even if any other method of aerial transit be attempted the additional difficulty presents itself of rendering the apparatus stable in high winds.

To steer a balloon does indeed appear a hopeless task; but to the question, is it possible that an aerial machine could be devised which would retain its position of equilibrium in the fitful and uncertain currents of the atmosphere, while at the same time it could be propelled at an angle more or less against the wind, so that by tacking it could, like a ship, navigate against the wind, it will be my endeavour in this and two following papers, from observation, experiment, and demonstration to answer in the affirmative.

The whole animal kingdom, from mammals, birds, fishes, lizards, and insects furnishes us with creatures more or less endowed with powers of flight; but it is more especially to the sailing flight of sea-birds that our attention will be at present directed. What must attract notice is their

prolonged power of buoyancy under certain circumstances with scarcely any flapping of the wings. On watching carefully this kind of flight it can be seen that the wings are kept nearly horizontal but with the anterior margin very slightly elevated above the posterior and thin edge of the wing. The angle thus formed by the wing with the line of motion is very small, indeed if it were not small it is easily proved that the onward motion of the bird would be quickly arrested from the quantity of air which would require to be displaced. It does indeed appear wonderful that a bird weighing perhaps ten pounds can be supported in this manner so long a time when it has once obtained a certain velocity. In every-day life, however, we have many instances of the lateral pressure of the air on planes in a direction transverse to the motion; we have only to walk slowly with a piece of paper held at an oblique angle to the line of progression, or to open an outer door of a building an inch or two if the door opens outwards when the wind is blowing obliquely in, when it will be at once noticed, and if a gale of wind is blowing it will be found impossible by main force to prevent the door flying open in a surprising manner if it is once opened a few degrees.

If solids are made to impinge on planes, then the angle of reflection is equal to the angle of incidence. If, however, a current of air impinges on a plane, then the elasticity of the air comes into play with very curious results. The following experiments, which I now repeat, were made with a view of ascertaining the action of the air on inclined planes at different angles:—

Experiment, No. 1.—If a book one or more inches thick is placed flat on a table, and any small light body is also placed on it, about as far beyond the book as the book is thick, it will be found impossible to so blow across the book as to send the light body away, for instead of moving from you it flies towards you.

Experiment, No. 2.—If a current of air is blown obliquely onto a table covered with sawdust, we shall observe that the whole of the sawdust affected by the wind is not blown in the direction of the current, but that a considerable portion is actually blown along the plane *towards* the primitive current.

Experiment, No. 3.—If a current of air blown through a tube impinges at any given oblique angle upon a point in a horizontal plane, the incident current $I\ P$ (figure 1) is not reflected at an equal angle to the plane from the point P along the line $P\ Q$, as might be supposed; for, if a lighted taper be held at Q, the flame is actually drawn downwards, and if the taper be moved over a large range of angular vertical measurement the flame is still drawn towards the plane.

These apparent paradoxes may be partly explained when we consider the perfect elasticity of the air; for when it strikes the point P it then, after compression, by virtue of its elasticity, diverges from P at all angles along the plane; so readily does it escape laterally that it appears to draw a large volume of formerly quiescent air down too.

Experiment, No. 4.—Reversing experiment No. 8, "action and reaction being equal and contrary," it follows that when a plane $A\ P\ B$ (figure 2) oblique to the horizon is carried with its upward and anterior edge in a horizontal direction, the tendency of the incident current $I\ P$ is not to be reflected along the line $P\ Q$, but the air is retained closer to the surface of the plane, which fact must very materially increase the lateral pressure, and therefore greatly assist in buoying up the plane.

Experiment, No. 5.—In order to ascertain the lifting pressure exerted by the inertia and elasticity of the air on a plane set at various angles and travelling with a given velocity, the apparatus here exhibited was devised; it consists of a thin sheet of metal a foot square, so connected with a spring balance that it can be set to any given angle. Action and reaction being equal and contrary, it is clear that if this instrument be set in a current of air the same effects are obtained as if the plane were moved at the same velocity through still air. The instrument was placed in a strong wind, and when the plane was first placed at a right angle to the current, with the spring so arranged as to show the horizontal pressure, it registered an average pressure of 2·7 lbs. on the square foot, indicating a velocity of the air of 23 miles per hour. The instrument was then so arranged as to measure the vertical pressure when the plane was set at various angles to the horizon. The following table gives a summary of the average results of a number of experiments therewith:—

Angle to Horizon.	Lifting Pressure in Lbs.
5°	1·13
10°	1·43
20°	1·65
30°	1·83
40°	2·00
50°	1·80

By this we see that the lifting pressure of a plane one foot square travelling through still air is more than half as great at an angle of 5° as it is at 40°, while we know that the resistance to its forward or horizontal motion is almost removed, for considerably less air has to be displaced. In fact, the inertia of the air is utilized with small angles, for considerably greater velocity can be imparted to the plane with the same expenditure of force.

From the foregoing experiments it appears that the law of "resolution of forces" as applied to solids is inapplicable in the case of gases. More-

over, the nature of the surface of the plane, and also the nature of the impinging body, materially influence the results.

These experiments assist in explaining the prolonged sailing flight of birds, for, when the wings are retained so as to form a very small angle to the horizontal line, there will still be a very considerable upward pressure to sustain the bird in its progress through the air; they also show that if, as has been asserted, birds prolong their flight by gradually increasing the angle of their wing planes, then that alteration need be and indeed can be only within very narrow limits; for a bird sailing in still air with its wing planes at an angle of 5° and travelling with a velocity of 28 miles per hour receives a support of 1·18 lbs per square foot of wing area, while if it alters its planes to 20° it only receives about half as much more support, even if we suppose its velocity unaltered; four times the angle of inclination to the horizon only giving one half more support. Now the resistance horizontally which the wing encounters at 20° is about 16 times as great as what it encounters at 5°, which would quickly arrest its progress, somewhat similarly to what may be observed when pigeons are alighting, for when near the ground they suddenly raise the anterior portions of their wings, their horizontal motion is stopped, a very slight rise is also noticed, and they alight without injury.

It appears, therefore, that it is only within small angular ranges that the alteration of wing plane prolongs the power of flight.

The wing of a bird is so constructed that it can be retained with sufficient rigidity at these minute angles.

Art. XV.—*Introduction of the Tension Wheel in Aerial Transit.*

By Henry Skey.

Plate IV.

[*Read before the Otago Institute, 9th October, 1877.*]

Attempts have been made to solve the problem of aerial flight by means of planes moved at great velocity in a rectilinear direction, but the difficulties to be overcome in starting, balancing, and steering them appear to present insuperable obstacles to success. The difficulties are not much lessened if we rotate rigid planes, if built up from a centre and worked therefrom, as great strength and inseparable weight would be required, and the weight of the axis and all the parts near it would act as so much dead weight.

That however a considerable ascensional force can be imparted to revolving planes is easily shown by the following experiment:—I take a

piece of thin, stiff card-board and cut a cross out of it; a slight obliquity is then imparted to the arms or planes, and a piece of wood is cemented through the centre to act as a vertical axis; if, then, rotation be imparted to it by the finger and thumb, it readily rises to the ceiling of the room. Varying the experiments as regards shape, etc., it is found advantageous to construct the planes broader towards the circumference; secondly, to bend the broad ends or tips somewhat downwards; and, thirdly, to impart a slight screw-form to the vanes in imitation of that possessed by a feather.

The boomerang, used as a missile by the Australian natives, affords an example how a horizontal force can be transformed into a lifting force. The wheel, here exhibited, has been devised with the idea of securing the planes in their true position, especially towards the tips, and of discarding all dead weight in those parts near the centre of the wheel where the motion of rotation is too slow to assist in elevating it. To effect these, I have constructed a horizontal wheel in which the circumference is, as it were, the basis or skeleton, and the radii act by tension so as to retain a light vertical axis in the centre. In this manner a surprisingly large, strong, and light wheel is obtained, the necessary weight of the circumference being utilized, as will afterwards be explained.

Two systems of radii are attached to the circumference of the wheel, each system containing eight pairs of tension strings; the tension of all these radii can be thus increased simultaneously by simply widening the systems on the axis.

By an inspection of the model, it will be seen that narrow pieces of tracing-cloth are attached between each pair of the tension strings; the anterior edge of each plane is attached to the upper side of the circumference, and the posterior edge to the lower side of it. The thickness of the rim thus gives the degree of obliquity of the planes, namely, 5° at the tips, while the planes are nearly horizontal near the axis. By this arrangement the resistance of the air to the motion of the radii is utilized in buoying up the wheel; and as the axis can be turned directly by a crank, the necessary speed of the circumference can be obtained by simply making the wheel large enough, thus dispensing with the friction which would arise if multiplying wheels were used—size of the wheel forming no theoretical objection in the limitless expanse. The waste of power by resistance and friction can be thus reduced to a minimum.

Though there must be great difficulty in observing the shape and position which the individual feathers and wings of birds assume while in actual flight, yet it is easy to fix them in a current of air and so watch the effect. In this way it will be seen that the posterior and thin edge of the feather yields more than the other parts in flight, especially towards the tips. The

tip end is also raised, so that the feather becomes less curved longitudinally, and assumes the figure of a thin and slightly bent knife, with the concave side downwards, the screw of the feather unwinding as it were.

If the feathers and wings of birds were straight when quiescent, and if every transverse section were inclined to the same angle—if, for instance, they were planes when not in action—then, when they came to be acted on by the air, they would, unless perfectly rigid, lose that proper figure essential to buoyancy, for the tips would twist more than the other parts, and the longitudinal section would become convex downwards. Perfect rigidity of a plane would necessitate too much weight.

We therefore see them formed with a twist or screw in the reverse direction to that in which the air itself twists them when in action. Then, when they come into action, they assume of themselves the proper and best figure, so that every part can act at nearly the same angle upon the air.

The action of the air itself confers the requisite rigidity, and the greater the speed or pressure, so much greater is the rigidity; the wing then assumes a knife-like figure approaching to a plane but slightly concave downwards.

This appears to be the figure of the wings of birds while sailing and wheeling, for when they are viewed when the eye is in the same plane as the wing they appear as shown in fig. 8, in which the wings are represented as mere lines. It will be noticed in the case of this wheel that this is also the figure which the tensile radii assume when in action.

The method here adopted allows of the very important advantage of using extremely thin anterior edges for the planes, whereby the air is cut, so to speak, for the nearer they approach to a mathematical line the better, as the resistance to the horizontal motion of the radii is surprisingly lessened.

When these planes are revolved with the same velocity as the wind, it is clear that even in a gale the wind cannot give any pressure against them except on the under and elevating sides.

Sailing birds first acquire a great initial velocity generally by flapping their wings. Naturalists and observers differ as to the direction of the vibratory motion of the wing in this kind of flight, probably on account of different birds being selected as examples, and omitting in some cases to mention whether the forward motion of the bird itself is included in the asserted direction of the stroke. For instance, a bird fastened by a string, or one which may be rising vertically, or, better still, a hovering bird, which we will assume to strike vertically downwards with its wings, would not really when in transit move them vertically downwards, although the stroke or attempt might be so; for the downward stroke compounds with the horizontal motion of the bird producing a forward and downwards or

oblique stroke. As the anterior edge of the wing is only slightly elevated in flight, a considerable upward pressure is received during the down-stroke of the wing as the air reacts on the concave side. As this stroke involves the most work, therefore the muscles which effect it are of great size and strength. We must not suppose that the up-stroke of the wing is only useful to so raise it as that it can be again depressed, for in the up-stroke we may detect one of the main provisions for its onward transit; for in the up-stroke, as the anterior portion of the wing is still more or less elevated, it is clear that a powerful forward impulse is thus given to the wing and thence to the bird.

As it is much easier to move the wing upwards than downwards, as the upper and convex side meets less resistance from the air, therefore the upward stroke is effected by smaller and weaker muscles, acting probably in a more disadvantageous position.

From the form and structure of birds and from the foregoing observations, it is apparent that a comparatively small force will start and propel them horizontally to that which is required to sustain them against the force of gravity; hence the attempt in the model before us to so construct the sails or wings that the tips are kept at a small but precise angle, and the whole length thereof is by its construction, when in action, compelled to assume a slight concavity. There is, however, a limit to this concavity, for as the principal part of the weight of the wheel is at the circumference, therefore the greater the speed the greater is the centrifugal force of all parts of the circumference, thus increasing the tension; the very slight elasticity of the rim thus coming into action.

Art. XVI.—*Introduction of the Principle of the Gyroscope in Aerial Transit.*

By Henry Skey.

Plate IV.

[*Read before the Otago Institute, 9th October,* 1877.]

All our ideas of stability of direction and position are but relative, and the same law which expresses that all matter moves in straight lines until deflected by another force, and which regulates a planet in its path, can give stability to an aerial machine, so that it can be propelled and steered in any direction even against moderate winds; indeed the most permanent thing in nature is the axis round which a symmetrical body rotates; we have many familiar instances of the permanency of the plane of rotation, from the child's missiles, tops and hoops, then again the wheels of bicycles,

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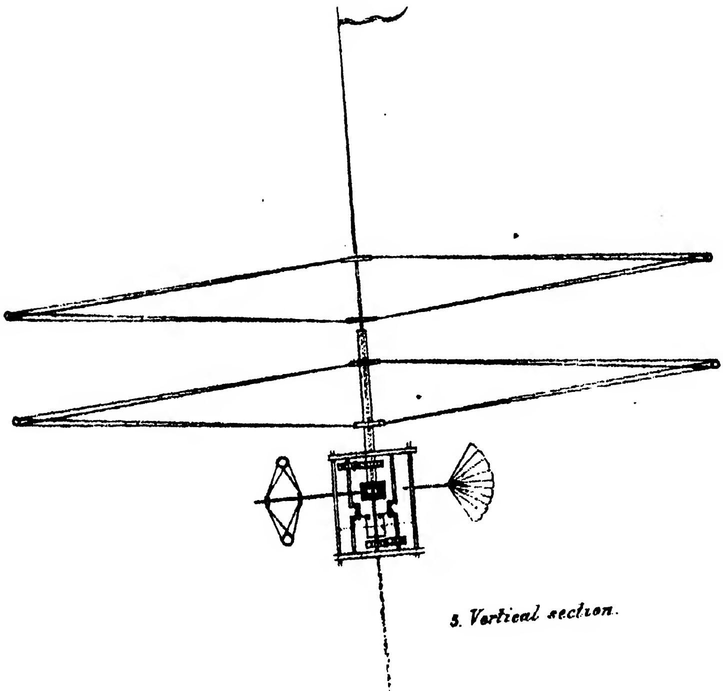
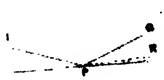


5. Vertical section.



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To illustrate Paper by H. Skey on Aerial Transit.

H. Skey, del.

on the small scale; while on the grand scale we have the axes of the earth and all celestial orbs as examples. A smooth thin stone thrown through the air keeps its plane of rotation nearly constant even when a high wind is blowing, the slight rotation in its own plane keeping it therein.

From experiments given in a former paper; * it was shown that when very oblique planes are moved through the air with the anterior edge only slightly elevated, there is not then much power wasted in driving a mass of air before them in a horizontal direction, and more than this there is a considerably less mass of air forced downwards, the inertia and elasticity of the air tending to impart great upward pressure unto the plane.

In a second paper † it was endeavoured to show how very thin planes could be preserved at a certain small angle, by letting them form the tensile radii of a large wheel, the circumference of which forms the basis or skeleton thereof.

If planes were made to travel in a rectilinear direction instead of in a circle, then, provided they could be kept in that line, the theoretical conditions for flight would be attained; for all the particles of the plane, by their direction and momentum, would contribute to the result; but as practical difficulties appear to be in the way, it becomes a matter of interest to enquire if the greater part of the weight of a wheel could not be so placed at its circumference as to obtain all the advantages of the rectilinear motion of the planes, while the weight absolutely necessary at the circumference of the wheel can at the same time be utilized as actually affording the best of all means of preserving it in its position of equilibrium after the manner of a gyroscope.

To effect this a wheel was constructed about thirty inches in diameter having a metal rim and with a light axis supported in the centre by tensile radii; the radii being nearly horizontal by construction there is little air to be displaced, and the resistance to the circular motion of the wheel is nearly reduced to the mere rubbing friction of the atmosphere; a great velocity can therefore be imparted to the wheel. When the axis is waxed it can be so rapidly rotated by the hands that, notwithstanding its weighing half a pound, the wheel rises for a short time off the floor, and the same if weighted; a considerably slower speed will however keep it in its plane of rotation, thereby proving that a lighter rim can be used. In large wheels paper tubing would be unequalled for rigidity and strength. A small wheel on the same principle was therefore constructed with a cane in place of a metal rim which manifested great buoyancy when rotated.

In order to prevent the framework or car which carries the wheel from rotating, I have attached another tension wheel thereto, with the opposite

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* Vide ante, Art. XIV. † Vide ante, Art. XV.

edges of its planes or radii elevated, and as this requires to be turned in an opposite direction, therefore the car is kept from rotating. In the model there is a crank in each of the axes and at the same height, and each crank is connected by a rod to a vertical pedal common to both; in this manner both wheels are compelled to rotate with the same speed but in opposite directions; it then follows that by turning only one of the cranks by the hand the whole apparatus would by reaction be guided in azimuth when required. In order to apply any power or force we must have a basis or part which acts as a fulcrum wherein action and reaction can have full sway. In birds and all flying creatures each wing is paired with another.

In the working compartment of this model the attempt has been made to so arrange the parts as to utilize the immense force which the human form is so eminently capable of exerting. The machinery is reduced to the simplest form, namely the two perpendicular winches between which manual power can be exerted in a sitting posture. These winches are merely U shaped bends in the prolonged axes of the tension wheels. Let us consider the power that can be exerted by the pull stroke. It is considered that, in rowing, manual power is applied in a very advantageous manner: the feet are firmly planted and the arms and shoulders react from them. It will be seen by the model that the feet can be placed on the nearly vertical pedal; great force could therefore be exerted by the legs alone: in fact great force can be exerted by the human form between two cranks in almost every part of the revolution when they go round in opposite directions. It is not expected that full manual power can be exerted continuously, as it is found that most work is done when there is a short period of rest, as in rowing; but it might be expedient to exert full power at some particular part of the revolution, hence the present arrangement whereby the feet or hands can be used either together or alone, thus avoiding dead points and allowing of the hands being used for steering. That far more power can be exerted by the legs than by the arms is easily proved by the fact of the weight of the body being raised for a whole day long in scaling mountains, whereas if the arms were to be used in pulling the body up under a ladder or an inclined rope, a few minutes would lead to exhaustion; and even if the power of the arms alone were used in any other mechanical arrangement, it would still be fatiguing. The arms working however between two vertical cranks allows of power being exerted in four ways; 1st., in pulling from the front, as in rowing; 2nd., in pushing in the opposite direction or forwards; 3rd., in pulling the cranks nearer to the body laterally; and 4th., in the reverse direction or pushing laterally outwards; and as this possibility of change is really important from its allowing one set of muscles to rest whilst others are operating, an account of a simple arrangement for varying

the method of working the feet may not be undesirable. If the broad pedal have the middle portion removed, and another pedal be inserted and made to work loosely on the same fulcrum, a double or rather quadruple pedal is formed; the top of this middle pedal is also connected by rods to the vertical axes of the tension wheels but by additional cranks placed on the opposite sides of the centres. In this manner the feet can reciprocate with one another as in walking or similar to their action in bicycles, and in a great variety of ways reciprocate with the arms.

This is all the machinery absolutely necessary for the purpose of elevation, and, as before remarked, the extra power required for progression and steering is comparatively small and can easily be applied as shown in the drawing, fig. 5, in which the axis of the upper tension wheel passes through the tubular axis of the lower one, and the framework or car is placed below; a horizontal axis is also shown as receiving motion by bevelled wheels, thus turning the vertical tension wheel, the vanes of which are set to about 20° and act as a screw propeller; while an expanding and completely adjustable fan in the rear acts as an auxiliary in steering, for it must be borne in mind that the sectional area of the machine is very small and in fact approaches to that of discs progressing edgeways.

A bird in full speed sailing through still air may be likened to the keel of a ship cutting through the water; the permanency of its direction must be very great. This persistency of its direction is, I think, made use of for buoyant purposes in high winds in a way that appears hitherto to have been overlooked. For instance a bird, in two parts of its evolutions, is travelling transversely to the direction of the wind, and when in these positions it can often be observed to elevate the tip of that wing on which the wind first impinges, while at the same time the other wing is slightly depressed. The under surface of the wings thus receive the wind, which is thus transformed into an elevating force; it is clear that a very long sweep can be thus made, for there is no head wind to impede the bird, but only the ordinary resistance of still air to be overcome. In wheeling in the air, it may also be observed that, as soon as the tip is brought down from the elevated position to the horizontal, the bird commences flapping its wings. Every current of air can thus be utilized by the bird, which does not appear to fly long directly against the wind, but it wheels and tacks to prevent fatigue. In fact, many sea-birds appear to fly with greater ease and swiftness when a stiff breeze is blowing, and it may be observed that they keep continually on the wing in gales, but rest much in calms as they sooner tire. When a bird has been elevated whilst sailing transversely to the wind as alluded to above, and also possibly when sailing a short time against the wind, it can then,

when it comes to that part of the evolution that is in the same direction as the wind, lower itself, and thus acquire additional velocity. There are, therefore, in this apparatus two most potent influences at work to preserve its equilibrium;—first, its cutting or keel-like property; and, secondly, its gyroscopic tendency of preserving its plane. This persistency of position, remarkable always in the case of the gyroscope, is rendered still more striking when the wheel is rotated in the air without any visible support.

A remarkable corollary of this arrangement of the aero-planes is the following:—If the advancing edge of the apparatus is kept slightly tilted upwards, we shall be able to utilize the very weight of the machine while in motion as a powerful auxiliary; for the planes *A* and *B* (fig. 4) in their longitudinal sections will be inclined upwards so as to receive a powerful lifting impulse from the induced current of air, while the planes *A'* and *B'* will be horizontal in their longitudinal sections and cannot therefore impede the advance.

Similarly the winds can be utilized even if adverse, as the edge which first catches the wind can be slightly tilted up, so that all the radii *A* and *B*, which could be lifted by the wind, can catch it; while all the other radii *A'* and *B'* which would otherwise be depressed will then be in a horizontal and neutral position. It therefore follows that all compounded horizontal air currents also admit of being transformed to a great extent into a buoyant force.

Art. XVII.—*On Floods in Lake Districts and Flooded Rivers in general, with Methods adopted for their Prevention and Control.* By H. P. Higginson, Mem. Inst. C.E.

Plate XIV.

[Read before the Wellington Philosophical Society, 2nd February, 1878.]

While at Queenstown, on Lake Wakatipu, during last November, a heavy rainfall was experienced, which, together with the melted snow on the main ranges, caused a rapid rise in the level of the lake. On Saturday morning, the 17th November, the rain-gauge at Queenstown registered ·66 of an inch, which fell during the previous night; and on Sunday morning an additional 1·61, making 2·27 inches during forty-eight hours. The rain being from the north-west melted the snow with great rapidity, causing an immense rush of water into the lake, the level of which rose over two feet in the two days.

While watching the water rising on the morning of the 18th, I observed that a mark which I had placed on the shore became rapidly covered and shortly afterwards exposed again, the surface of the lake being at the time perfectly calm, not a ripple ruffling it.

As I found it difficult to account for this, I made more careful observations for upwards of an hour, the result of which was that I ascertained there was a rise and fall of three inches in the level of the water at intervals of five minutes, which was maintained with perfect regularity. This rise and fall was extremely gradual, so that it was quite imperceptible on the smooth surface. After 1 p.m. a breeze sprang up, preventing a further continuance of my observations. I was unable at the time to account for this disturbance satisfactorily, but was inclined to attribute it to a slight earthquake, possibly too faint to be noticed.

In conversation with Mr. Worthington, the Meteorological Observer, the next morning, I mentioned what I had remarked. He informed me that he had himself noticed the same rise and fall on a larger scale, after one of the heaviest floods experienced; consequently it at once pointed to the floods being in some manner the cause, though at first sight it seemed impossible for any flood to have such an effect on a body of water nearly fifty miles in length and of great depth.

Having repeatedly thought over the matter without being able to account for it in a satisfactory manner, I put together a few facts relating to the natural features of the lake with reference to this flood, in order to assist me in coming to some conclusion, which I therefore beg to suggest to you. I have also tabulated the effect of this flood in conjunction with some that have occurred in the European Alps, in districts bearing similar features, the information being taken from Beardmore's "Manual of Hydrology."

Lake Wakatipu is nearly fifty miles in length, and varies between one-and-a-half and three-and-a-half miles in breadth, its area scaled from the map being 113 square miles. Its drainage area is about 1,200 square miles, principally at the northern extremity, where the water-shed is the main range of Southern Alps drained by the rivers Dart and Rees. These two rivers flow into the extreme northern apex of the lake, having a drainage area of 400 square miles or a third of the whole commanded by the lake, including the portion covered with perpetual snow and glaciers.

The rise of two feet in the level of the lake means 1,823 cubic feet of water per minute per square mile impounded. At the same time the river Kawarau at the outlet was discharging 500 cubic feet per minute per square mile based on the rainfall for the first sixteen days in November. This makes a total of 2,323 cubic feet per minute per square mile run off the drainage area

of the lake during the 17th and 18th November. This quantity is equivalent to a depth of 1·439 inches per diem run off the whole drainage area.

The observed rainfall at Queenstown during the two days being 2·27 inches or 1·135 per diem, of which we can only count upon three-fourths as having run off (this being the proportion observed to do so in similar districts in Europe) we can only attribute ·851 inch over the whole area to rainfall. Consequently the difference must be derived from the melted snow and ice running from the mountains.

I may observe here, that Queenstown being nearly at the centre of the drainage area, the registered rainfall may be taken as a fair average; and that at the late period of the season when this flood occurred, the snow on the mountains immediately surrounding the lake had almost entirely disappeared.

The following table will give the above results more clearly:—

—	Cubic feet per minute per square mile.	Cubic feet per minute.	Equivalent depth run off per diem. Inches.
Rainfall	1,373	1,647,600	·851
Snow	950	1,140,000	·588
TOTAL	2,323	2,787,600	1·439

From the above figures we can approximate the proportion of the flood-water running into the head of the lake by the rivers Dart and Rees:—

		Sq. Miles.	
Rainfall	1,373 ×	400 =	549,000
Snow	950 ×	1,200 =	1,140,000
TOTAL CUBIC FEET PER MINUTE			1,689,000

As in the former table it was shown that the total flood-water amounted to 2,787,600 cubic feet per minute, it is evident that considerably more than half the whole quantity rushed into the lake at the extreme north end, or head as it is termed. Accepting these to be the facts, the question is,—Would this mass of water flowing rapidly (possibly in much less than forty-eight hours) into one extremity have sufficient effect to cause the disturbance observed?

I have been unable to find any other explanation, and believe that the following are the reasons. I would ask you to examine the conformation of the lake, and observe that it is throughout a long and narrow one, and that opposite Queenstown there are two bends or elbows of more than right angles; in point of fact, a wave passing down the lake would be deflected

about 100° from the axis of its course, about eighteen miles from where generated, in order to pass round the first of these. This, therefore, is not probable. The result would be, I think, different, and would possibly account for the pulsations noticed.

We will presume that this large body of water in passing into the lake created, while endeavouring to find its level, a gentle swell or wave which, from the conformation of the lake, could only be propelled in the direction of its length; this, upon arriving at the first bend would impinge against the southern shore, and instead of passing round the bend would be reflected back towards the northern side of the lake, and so create an oscillating wave which, upon reaching Queenstown Bay, would rise and fall at intervals corresponding to the time occupied by the wave crossing backwards and forwards.

Beardmore, the hydraulic engineer, while describing the effect of tidal disturbances in rivers, remarks,—"When the reaches of the rivers are straight the bore travels evenly up the river; but at turnings it is thrown off towards the further side, where it rises higher than in the straight reaches. Thence it recoils and impinges upon the opposite shore, and so, like a disturbed pendulum, it oscillates from side to side, and only regains its steady course when the reaches lengthen."

Were the shores of the lake flat and sloping, with the depth of water gradually shoaling off, a wave of this description would be carried by its impetus up the slope, consequently rapidly parting with its energy. The shores of the lake are, on the contrary, almost perpendicular rocky cliffs, with deep water close up to them, thus assisting the transmission of an oscillating wave.

The width of the lake opposite Queenstown is about three miles, but a wave as before described would, in consequence of travelling a diagonal course, considerably increase the distance. On the accompanying sketch of the lake (Plate XIV.) I have indicated what I consider the probable direction that this wave would take, which in crossing opposite Queenstown measures about five miles, or ten miles during each pulsation; and having observed the intervals to be five minutes, it naturally follows that its velocity would be 120 miles per hour. Assuming this to be the case, according to Professor Airy's formula, it would necessitate a depth of 1,000 feet.

Soundings have been taken,* and the greatest depth off Collins Bay is given as 1,296 feet, the bottom rising gradually towards the head of the lake, so that I assume the depth of that portion between the two bends to

* Hector: Report Geol. Surv. Otago, Prov. Council Papers, 1864, p. 86; and "Trans. N.Z. Inst.," vol. II., p. 373.

be between 1,000 or 1,200 feet, which is sufficiently near to support my theory. I do not attach any scientific importance to what I have described, though, there being reasons for every function of nature, it is both interesting and our duty in the cause of science to seek for and obtain an explanation of those reasons.

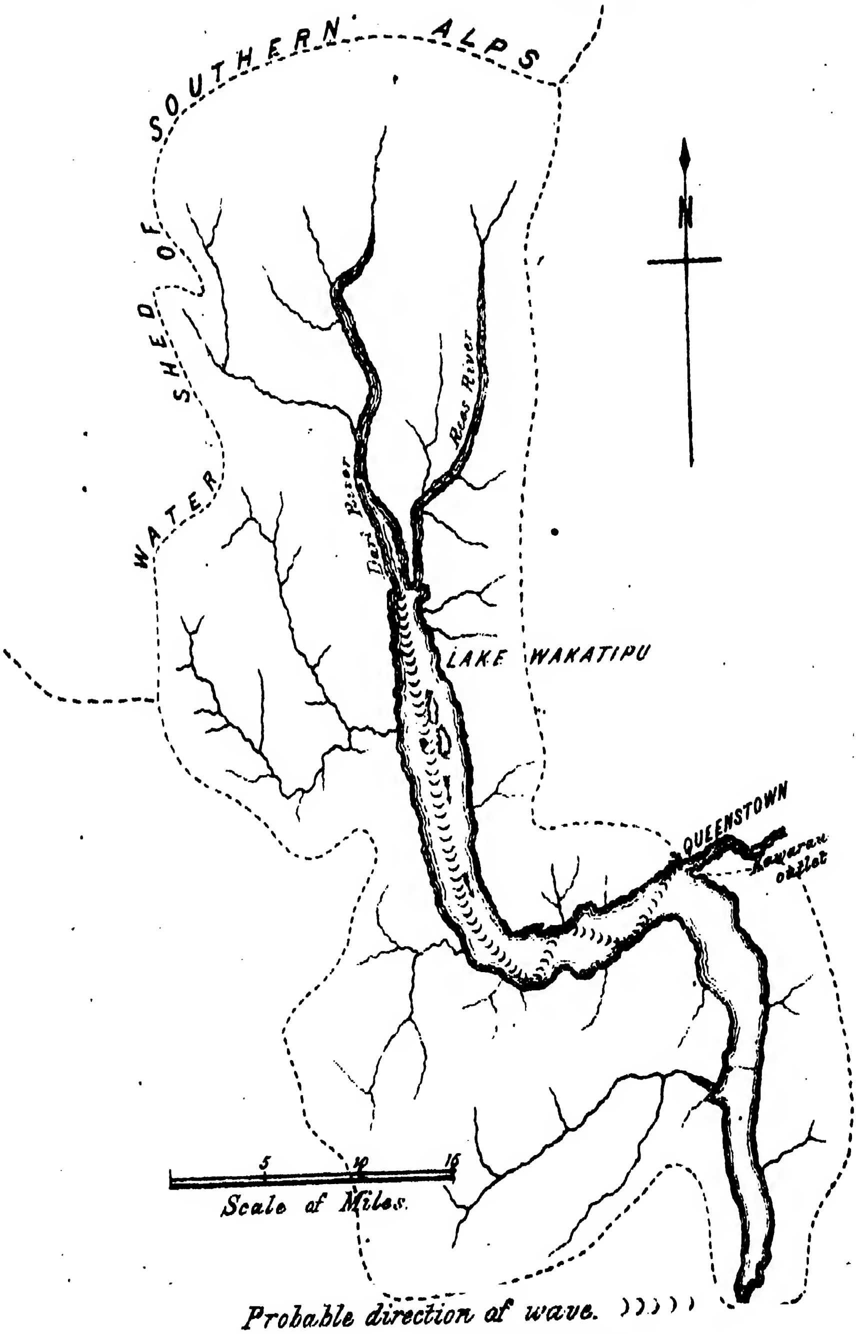
While considering the magnitude of the floods in these mountainous districts, I should like to draw attention to a fact that I have no doubt is well known to most of you, namely, the beneficial effects that these lakes exert in restraining the rush of heavy floods. They act as reservoirs, in which are stored up the enormous bodies of water pouring off the precipitous slopes of the mountains, gradually allowing it to find its way to the sea in restrained quantities. They also do good service in arresting the shingle and débris washed off the hills, and carried into the torrents by glaciers and land-slips.

Taking the case of the Molyneux, or, as it is generally termed, the Clutha, it requires no great stretch of imagination to picture to oneself what the aspect of the lower valleys would have become were it not for the influence exerted over the floods by Lakes Wakatipu, Hawea, and Wanaka. These valleys would, in all probability, have been deserts of shingle and sand where not water.

The Rivers Rangitata, Rakaia, and Waimakariri, in Canterbury, have few lakes on their tributaries—the former and the latter none of importance whatever. The nature of their beds is well known, and requires no description by me. They are a continual source of anxiety to the settlers in their proximity, as the flood-channels alter their course during each successive flood, inundating and destroying the land near them, and costing large sums of money annually in endeavours to restrain and control them.

There are many other smaller rivers in both islands having somewhat the same characteristics, and which almost annually do great harm both by flooding and encroaching on the cultivated land near the banks; consequently the question of how they should be treated, in order to regulate and control them, becomes more and more serious, as it is, I believe, an established fact that the high floods are becoming still higher, as well as oftener repeated.

We need not go far to seek for an explanation. The rapid destruction of timber and brushwood along the banks will give rise to encroachment, as on the Hutt River. The extensive bush fires on the ranges, and even the felling of timber for use, allows the heavy rains to flow more quickly off the surface into the streams, as, consequent upon the destruction of the larger trees, the smaller ones perish. As a bush country becomes settled and the timber cleared, so will the floods become more violent in their nature; and,



Probable direction of wave.)))))

Boundary of drainage area -----

what will eventually prove more serious, should the destruction of timber not be checked, many of the streams will dry up during the summer months.

The Commission of Italian engineers which has lately investigated the cause of the recent terrible floods in the River Po, reported that during the present century these floods have been progressively increasing in height; that the expedient of attempting to confine them within the channel of the river by continual additions to the height of the artificial banks, has been considered inapplicable, as being a method tending to increase the very dangers it is intended to prevent.

For this reason the object sought by the commission was rather the reduction of the floods themselves, or at all events the arrest of their increase. This involved the investigation of the influence on the volume of the river of the denudation of the growth of wood on its banks; the suggestion of legislative measures; the construction of storage basins or lakes to retain the flood-water for subsequent distribution for the purposes of irrigation, together with numerous other matters affecting the river. The result of this examination was that they estimated it was necessary to spend £600,000 in strengthening and restoring the banks, and a further sum of £320,000 for subsidiary works.

Another Commission also lately appointed to report on works necessary to prevent inundation of the River Tiber in Rome, had the following proposed remedies to investigate and report on—

1. Re-wooding the banks of the Tiber
2. Storage lakes or basins of reserve
3. Total deviation of the course of the Tiber
4. Partial diversion of the water
5. Limitation of the flow through the city
6. Rectification of the channel
7. Additions to the banks and lateral defences.

The Commission decided to increase the discharging capabilities of the two channels existing, by widening and clearing the bed within the city and embanking and regulating the course above it.

These particulars are obtained from the Italian Civil Engineers' Journal, and a writer in the same remarks, with reference to the remedies mentioned in the before-mentioned list, that with regard to the first remedy of re-wooding the banks too little is known of the requisite details, and that the result of any operation of this nature would be too slow in its development for it to be relied on as a prevention of flood; as to the second proposal of storing storm water in artificial lakes, the only experience cited in modern times is in the basins of the Upper Loire in the south of France, which works were executed in 1711.

After the disastrous floods of 1846 and 1856 these basins were taken as models for numerous projects, one of which was the establishment of eighty-eight storage lakes of a similar kind on the Loire and its affluents, proposed by Mons. Comoy. One of these basins was commenced in 1861 on the river Furens, an affluent of the Loire near St. Etienne, but before the completion of the work its destiny was altered, and the water, which was retained by a masonry dam 170 feet high, was applied as a motive force.

The greater number of Italian engineers are not favourable to the plan of storage basins. Signor Lombardini, the famous hydraulic engineer, remarks, with reference to the case of the Loire, that the basins proposed in the valleys of that river would have cost £2,600,000 to store a mass of water, the withdrawal of which from the supply would result in the lowering at the point of juncture of the two streams, of the Allier by 2·3 feet, and of the Loire by 3·3 feet, which is an insignificant result when compared with the expenditure required to effect it.

I have quoted these particulars regarding what has been done in the matter of late years in Italy and the South of France, in order to show the importance with which the subject is regarded where the rivers bear very much the same character that they do in New Zealand.

Before undertaking works of this nature here, we should as far as possible reap the benefit of the extensive experience gained in the older countries. Volumes could be filled with examples of the works that have been undertaken with a view of regulating and controlling the floods in rivers, and recording the results; a thorough study of the whole subject is, however, the only manner in which to understand the measures employed, including if possible a personal examination of the works themselves.

It may be said that though these European rivers bear somewhat similar features to those in New Zealand, they differ sufficiently to require a distinct mode of treatment. This is true of all rivers to a great extent, as the slightest variation in the slope of their beds, the different nature of the country through which they flow, the geological features of the mountains in which they rise, and many other circumstances, render it necessary that each should be considered separately and treated differently.

As previously mentioned, one method generally proposed for the protection of river banks is by planting them, which in very many cases means re-planting them, as most rivers have been more or less wooded originally. This method has been practised on some of the Alpine tributaries of the Italian rivers, but I am not aware of the results. It would be a most difficult plan to carry out successfully, and would necessitate the purchase or reserving of the land for a considerable width on both banks, and that it should be fenced in to protect the young trees

from cattle. How much simpler would it have been to have reserved the original bush!

I do not suppose that the banks of the rivers on the Canterbury plains have been ever wooded—certainly not since the settlement of the country—and I doubt if this method of planting would be of any avail in their case, as the impetuosity of the floods and loose character of the banks would be fatal to the growth of plantations. In some places willows have been planted as a protection to the railway banks, and promise to succeed, though had they been introduced on a larger scale there would have been a better chance of ultimate good results. It is only in the lower reaches of these rivers that they break over their banks, as they flow for the greater portion of their course across the plains between well-defined terraces, which gradually die out when the sea coast is approached.

As the slope of these river-beds generally becomes less upon nearing the sea, the consequent reduced velocity of the current affords a better opportunity for trees to succeed if exposed to it. Upon approaching the hills the velocity and consequent strength of the current during floods may be instanced in the case of the late rise in the Rangitata, where square blocks of concrete, nearly two tons in weight, were carried upwards of a quarter of a mile down the stream. In such a position no tree-planting could be of any avail.

The construction of storage reservoirs, in imitation of the lakes alluded to at the commencement of this paper, seems to me the most effectual manner in which to control floods, and which would at the same time arrest the shingle perpetually travelling from the mountains to the sea. This travelling shingle is generally the cause of diversions of the rivers from their proper course. An obstacle, such as a fallen tree grounding in the bed, causes a reduction in the velocity of the current, immediately causing the shingle in motion to deposit behind it; this shingle bank will increase in size till it causes the stream to branch off in a new direction, in many instances to the destruction of valuable land.

In the case of the storage reservoir on the River Furens, one of the latest examples (as previously alluded to), it was constructed of sufficient capacity to impound sixty-five per cent. of the average yearly rainfall. This was a most extravagant manner in which to arrest the floods, though most effectual. It, however, was so constructed for the double purpose of storing water, for supplying power, and for use otherwise in the manufacturing town of St. Etienne situated immediately below it. It was thus made remunerative. The cost is stated to have been £63,600, and it is paying two-and-a-half per cent. on that amount. Had it been constructed only for the purpose of regulating the floods in that river, it need only have

been of sufficient capacity to impound the amount of water brought down by a maximum flood of a few days' duration, allowing it to pass gradually down the river in such a volume as the channel might be capable of carrying without injury; after which, when empty, it would be available to repeat the process. Though this plan appears to have been condemned for the purpose on large rivers such as the Loire, it is quite possible that there may be cases where, on smaller streams, subject to sudden heavy floods, it might be carried out with success.

To attempt this plan in New Zealand, where there is little probability of its proving directly remunerative, nature must first be called upon to furnish a site where a storage basin would haye a wide-spread area, easily enclosed at some narrow rocky gorge on the river to be treated. Such a site being found, it would (presuming that the fall of the ground be not too great) require a dam of only moderate height to impound sufficient water for the purpose. Unless such natural sites can be found, the cost would be out of all proportion to the results. Earthen dams would be sufficient provided proper discharge tunnels could be driven through rock, they, however, do not answer so well as masonry, where liable to stand dry for any length of time, as sun-cracks and vermin imperil their stability when the next floods are impounded.

The other methods of dealing with the case, such as enclosing the flood waters by enbankments running parallel with the course of the river, enlarging the channels, etc., are the most universally adopted, but are only applicable to rivers with a moderate fall, where the velocity of the current is not too great to destroy them; they are by far the easiest to construct, though from too limited a knowledge of the floods and their effects, and from being usually undertaken piece-meal, without any general and well-considered design, they are liable to failure. The maintenance of this description of work is also very costly, entailing as it must do extensive reconstruction and repairs after each successive high flood.

It is a most essential thing that all such works wherever contemplated should receive great consideration. It is impossible to collect too much information, both regarding the behaviour of rivers when low and in flood, as well as for a complete system of surveys and levels, in order to enable the manner of treatment to be determined. There is no branch of engineering so difficult to undertake successfully.

TABLE OF COMPARISON OF GREAT FLOODS IN EUROPEAN ALPINE LAKE DISTRICTS, WITH LAKE WAKATIPU

DURING THE FLOOD OF THE 17TH AND 18TH NOVEMBER, 1877.

LOCALITY.	Drainage Areas.			Quantity impounded per square mile.	Estimated discharge per square mile.	Total quantity run off per square mile.	Depth run off per diem.	Date of Flood.	Remarks.
	Areas of lake.	Drainage area.	Total.						
	Square miles.	Square miles.	Square miles.	Cubic feet per minute.	Cubic feet per minute.	Cubic feet per minute.	Inches.		
Lake of Geneva..	208	2,792	3,000	1,120	530	1,650	1·02	17th and 18th Sept., 1840 ..	Observed rainfall at Geneva in 24 hours = 2·83 inches.
,, ,,	,,	,,	,,	757	618	1,375	·90	28th May to June 1st, 1856..	Do. do. do., = 1·476 in. in 24 hours.
,, Maggiore ..	77	2,418	2,495	2,550	400	2,950	1·83	21st and 22nd October, 1857	Due principally to melting snow.
,, Wakatipu..	113	1,087	1,200	1,823	500	2,323	1·44	17th and 18th Nov., 1877 ..	Average rainfall observed for two days = 1·135 in. The results are in a great measure due to melting snow.

ART. XVIII.—*On a means of selecting the most durable Timber.*
By JOHN BUCHANAN.

[Read before the Wellington Philosophical Society, 21st September, 1877.]

THE purpose of the present paper is to explain a method by which timber of the greatest utility, from trees of any species, may be determined.

In the selection of timber for constructive purposes the only guide hitherto has been the prevailing vague opinion that the timber of certain trees is durable; experience, however, has often proved that failures take place with some of those species most highly valued, such as totara, (*Podocarpus totara*). In all such cases the failure has probably resulted from that indiscriminate system which prevails of cutting down every tree within reach, including young immature trees and quickly-grown mature trees on rich alluvial bottoms, which always produce an inferior timber; the use of such inferior timber in wharves, piles of all kinds, or fence stuff, can only result in premature decay.

As a means to enable engineers to determine the value of any timber I propose the adoption of a standard test of weight, based on an average weight determined from at least twenty measured cube specimens of each species, the specimens to be well seasoned, procured from different districts, and grown under different conditions of growth. By comparing specimens of the same cubic bulk of any timber with its own standard, the most durable of that kind may be selected; as it may be accepted as an axiom in the physiology of timber, that the best will possess the closest structure, contain the largest amount of secretions, and consequently will prove the heaviest and most durable.

If, however, our New Zealand timbers in their natural state, and selected by the test of weight, do not come up in durability to the necessary requirements, there is still in reserve the auxiliary means used in other countries, by which inferior timber is made durable, such as charring, or by the infusion of antiseptic fluids into their structure, and it is possible the colony may ere long waken up to the fact that the introduction of such preservatives has been already too long delayed.

II.—ZOOLOGY.

Art. XIX.—*Notes on the Ornithology of New Zealand.* By Walter L. Buller, C.M.G., Sc.D., F.L.S.

[*Read before the Wellington Philosophical Society, 1st December,* 1877.]

Following a plan which I have pursued for some years, I beg to lay before the Society a budget of notes on various species of New Zealand birds, without any attempt at systematic arrangement. As natural history is made up chiefly of facts and observations, every recorded note is an additional contribution, however small, to the general fund. Facts, in themselves trivial, are often found to assume an importance in relation to other facts; and a random note sometimes supplies a missing link in the carefully elaborated chain of the systematic philosopher.

It will be seen that in the following notes I have embodied, sometimes in my own language and sometimes in his, the observations of Captain Gilbert Mair, F.L.S., who, during a long residence on the East Coast, has paid special attention to the native birds inhabiting that part of the country. In addition to habits of careful observation, he possesses a good knowledge of the birds themselves, and this adds very much to the value of his statements.

Before proceeding to my own notes, I desire to call attention to the following passage in a very interesting paper by Mr. W. Colenso, F.L.S., published in the "The Tasmanian Journal of Natural Science," as far back as April, 1845, which I have only lately had an opportunity of reading:—
"A little below Ngaruawahie (in the Waikato district) we met a man in a canoe with a live and elegant specimen of the genus *Fulica*. I hailed the man and purchased the bird, which he had recently snared, for a little tobacco. It was a most graceful creature, and, as far as I am aware, an entirely new and undescribed species. Its general colour was dark, almost black; head grey and without a frontal shield; fore-neck and breast ferruginous red; wings barred with white; bill produced and sharp; feet and legs glossy olive; toes beautifully and largely festooned at the edges; eye light-coloured and very animated. It was very fierce and never ceased attempting to bite at everything within its reach. I kept it until we landed, intending to preserve it, but as it was late, and neither material at hand nor time to spare, and the animal too, looking so very lovely that I could not

make up my mind to put it to death, I let it go; it swam, dived, and disappeared. From its not possessing a frontal shield on the forehead (which is one of the principal generic marks of the Linn. genus *Fulica*) it may possibly hereafter be considered as a type of a new genus, serving to connect the genera *Fulica* and *Rallus*. Not a doubt, however, in my opinion can exist, as to its being naturally allied in habit and affinity to the *Fulicæ*; I have therefore named it *Fulica novæ-zealandiæ*. In size it was somewhat less than our European species, *F. arua*."

The bird so well described by Mr. Colenso is evidently quite distinct from *Fulica australis*, the only species of coot known to inhabit Australia, and as it has never, so far as I am aware, been heard of since this capture, more than thirty years ago, we may fairly conclude that it is one of the ornithic forms that have become extinct within the memory of man.

Nestor meridionalis, *Gray*.—Kaka Parrot.

This bird is very abundant in the Urewera country, and during the short season the rata is in bloom the whole Maori population, old and young, are out kaka-hunting. An expert bird-catcher will sometimes bag as many as 300 in the course of a day; and at Ruatahuna and Mangapohatu alone it is said that from 10,000 to 12,000 of these birds are killed during a good rata season, which occurs about every three years.

There are several modes adopted for catching the kaka, but the commonest and most successful is by means of a trained *mokai* or tame decoy, the wild birds being attracted to artificial perches, skilfully arranged around the concealed trapper, who has simply to pull a string and the screaming kaka is secured by the leg, as many as three or four being often taken at the same moment. At the close of each day the dead birds are buried, and when a sufficient number have been collected they are unearthed, stripped of their feathers, fried in their own fat, and potted in calabashes for winter use, or for presents to neighbouring tribes. The perches used for kaka-trapping are often elaborately carved and illuminated with *paua* shell.

Eudynamys taitensis, *Gray*.—Long-tailed Cuckoo.

During its sojourn with us this species is generally met with singly or in pairs, but Captain Mair gives the following interesting particulars of a summer flight:—"Passing down the Hurukareao river, in the Urewera country, during the intensely hot weather of February, 1872, I was astonished at the number of koheperoa that coursed about overhead. During the three days that we were making the passage, I saw some hundreds of them, swarming about in the air like large dragon-flies, as many as twenty or thirty of them being sometimes associated together. The loud clamour of their notes became at length quite oppressive. There

was much dead timber on the banks of the river, and it appeared to me that the birds were feasting on the large brown cicada. This is the only occasion on which I have observed this species consorting as it were in parties."

CHRYSOCOCCYX LUCIDUS, *Gould.*—Shining Cuckoo.

Respecting our little migratory cuckoo, Captain Mair furnishes the following notes:—"Speaking from ten years' observation of this bird in the Tauranga district, I may state that it never sings after the middle of February and seldom after the beginning of that month. As late as the end of March or beginning of April, during several successive years, I have met with these birds in the Mangorewa forest between Tauranga and Rotorua, but never heard them utter a note at this season. I have seen numbers of them perched in silence on the branches of the poporo (*Solanum nigrum*), always in full feather, but absolutely songless. This I regard as a very curious fact. On the subject of their parasitic habit of breeding, I may add that on two occasions I have seen the young cuckoo fed by the grey warbler—a bird considerably its inferior in size; and I can further attest, from personal observation, that the same little bird performs the like parental office for the young of the koheperoa, or long-tailed cuckoo, as sketched in Dr. Buller's 'Birds of New Zealand.'"

POGONORNIS CINCTA, *Gray.*—Stitch-bird.

Captain Mair informs me that this handsome bird is still plentiful on the West Coast between Raglan and Waikato Heads, also in the ranges behind the Wangape Lake in the Lower Waikato.

It was formerly comparatively abundant in the wooded hills around Wellington and flanking the Hutt valley, but for some years past not a specimen has been obtained.

ANTHUS NOVÆ-ZEALANDIÆ, *Gray.*—New Zealand Pipit.

In former papers I have mentioned the frequent occurrence of albino ground-larks, and commented on the remarkable tendency generally to albinism in many other species of bird in New Zealand—a fact not easily accounted for in a temperate and equable climate like ours. This abnormal feature appears to be extending itself to the introduced birds, and the following newspaper clipping furnishes an instance;—

"As an ornithological curiosity an up-country paper mentions that a gentleman residing near the Wairarapa Lake has noticed on his run two English larks, the one being pure white and the other as yellow as a canary."

RHIPIDURA FULIGINOSA, *Buller.*—Black Fantail.

Since my last notice of this species, three more instances of its occurrence in the North Island have come to my knowledge.

Major Mair reports another example from the Pirongia ranges in the Waikato;* a second has been met with in the bush near Major Marshall's (Upper Rangitikei); and a third is reported from Auckland. Of the last-mentioned Mr. T. F. Cheeseman, the Curator of the Auckland Museum, writes me:—"You will be interested to hear that a solitary individual of the black fantail has been repeatedly seen near Auckland this winter. It was first noticed by Mr. James Baker in his garden at Remuera; afterwards it visited Mr. Hay's nursery garden where it remained for some weeks; and it has since been noticed about several of the residences at Remuera. I was fortunate enough to see it one evening when walking home, and can consequently vouch for its being the South Island species. Its occurrence so far to the north is certainly very remarkable."

Carpophaga novæ-zealandiæ, *Gray*.—Wood-pigeon.

At the Rev. Mr. Chapman's old mission station at Te Ngae (Rotorua), formed in 1835, and now much out of repair and overgrown, there are several hundred acres of sweet-briars, run wild and presenting quite an impenetrable thicket. During the autumn months, when the red berries of the briars are fully ripe, large numbers of our wood-pigeons resort to these grounds to feed on this fruit, and at this season become exceedingly fat.

In the Rev. Mr. Spencer's fine old garden at Tarawera, where well-grown specimens of English oak, elm, and walnut mingle in rich profusion with almost every kind of native tree and shrub, a pair of these birds some time ago took up their abode and bred for two successive years, at a spot not fifty feet from the reverend pastor's study windows. And they would doubtless have continued to breed in this quiet retreat had not one of the Maori school-boys, anxious to try his fowling-piece and wholly unmindful of the occasion, shot both birds during the breeding season, leaving a pair of callow young to perish miserably in their nest.

Tringa canutus, *Linn*.—The Knot.

Mr. Cheeseman, of Auckland, sends me the following note, under date August 14:—"Has the knot (*Tringa canutus*) been previously recorded from the North Island? My brother shot a specimen (in winter plumage) in Hobson Bay a few months ago, and the skin is now in the Museum. I believe that I have frequently seen it on the extensive mud flats near the mouth of the Thames river."

This is the first authentic record of this species in the North Island; but Captain Mair has described to me a bird found associating, in considerable numbers, with the kuaka and dottrel on the East Coast, which I have no doubt is the same. It has not, however, been met with yet on the Wellington coasts; and the only specimen in the Colonial Museum is one which I

* *Vide* "Trans. N.Z. Inst.," IX, p. 330.

received from Dr. von Haast some years ago, as a novelty from the south.

Limosa novæ-zealandiæ, *Gray*.—Godwit.

Captain Mair has contributed something more to the history of this migratory wanderer. In my account of the species* I have stated that our godwit spends a portion of the year in Siberia, and visits in the course of its annual migration the islands of the Indian Archipelago, Polynesia, Australia, and New Zealand. Von Middendorff, who met with these birds in great numbers in Northern Siberia (74–75° N. lat.), states that they appeared there on the 3rd June, and left again in the beginning of August. In the months of September and April, Swinhoe observed migratory flocks on the coast of Formosa; and during the winter months he met with the species again still further south. Von Middendorff found it also in summer on the south coast of the Sea of Ochotsk, although it did not appear to breed there; and it has likewise been observed in China, Japan, Java, Celebes, Timor, Norfolk Island, and the New Hebrides. I have already described the manner in which they take their departure from this country, at the North Cape, towards the end of March or beginning of April. Rising from the beach in a long line and with much clamour, they form into a broad semi-circle, deployed forwards, and, mounting high in the air, generally take a course due north. Sometimes they rise in a confused manner, and, after circling about at a considerable height in the air, return to the beach to reform, as it were, their ranks, and then make a fresh start on their distant pilgrimage. The departure from any fixed locality usually begins on almost the exact date year after year; and for a week or ten days after the migration has commenced fresh parties are constantly on the wing, the flight generally taking place just after sunset. The main body fly in silence, but the straggling birds cry out at intervals, while endeavouring to overtake the flock in advance. Near the North Cape, Captain Mair has observed them flying northward in tens of thousands, and always in considerable flocks, numbering from 700 to 1,200 birds in each, and the wonder is where they all come from. During the period mentioned, this excitement of departure is unabated—flocks forming and following each other in perpetual succession. Though the greater number of the birds migrate, some remain with us during the winter, and it is not unusual, even in mid-winter, to see a flock of several hundred consorting together on the sand-banks. It has been remarked that at this season they are much tamer and more approachable than at other times. On their return to this country they do not make a sudden appearance, but gradually become more plentiful after the first week in November, and about Christmas they are in full force again all along our sea shore. Capt. Mair has sometimes observed

* "Birds of New Zealand," pp. 199, 200.

a party of stragglers in Sulphur Bay, in the Rotorua Lake (about forty miles from the sea coast), no doubt brought inland by the easterly gales, which sometimes prevail for a considerable time without intermission. On the Tauranga coast he has obtained large "bags" during the shooting season; and on one occasion, at Cemetery Point, killed ninety-seven at a single shot with a heavy charge of No. 5 from an ordinary fowling-piece. This will give some idea of their numbers, and of the close manner in which they were packed together. Thousands were crowding upon each other on an insular sand-bank, and numbers more were hovering overhead in the vain attempt to find a footing among their fellows. As he was "shooting for the pot," he concealed himself with floating kelp, and crawled up under water till the birds were within easy range.

The natives catch large numbers of them by spreading flax snares horizontally on manuka sticks twelve or fifteen feet high, and arranged in the following manner:—A number of stakes are driven into the ground at equal distances so as to cover the area of the customary resting-place. A perfect network of flax-loops or running nooses, about twelve or fifteen inches in diameter, are then spread or hung in such a way as to form a canopy or roof supported by the stakes. The birds on assembling in the evening fly low and take up their position on the resting-ground to wait for the ebb of the tide. At this conjuncture the natives spring out from their concealment with lighted torches. The birds at once rise vertically, in confusion and alarm, and large numbers become entangled and caught in the running loops, sometimes as many as 200 being captured at one time in snares covering a space of twenty by forty yards. These snares are only set on calm and dark nights, for the obvious reasons that, if there was any wind, the loops would become disarranged, and that on moonlight nights the birds would see the nets and avoid them. Sometimes during wet easterly weather in summer the feathers of these birds become so saturated that they are unable to fly. The natives take advantage of this and capture large numbers of them by running them down.

From what has been said, it may be inferred that they are esteemed good eating by both settlers and Maoris. The latter always cook the bird unopened, and devour the contents of the stomach with a relish. When very fat they are potted in the orthodox fashion and "calabashed" for future use.

I have never met with a native who could tell me anything about the breeding habits of the godwit, and it has become a proverb amongst them: "Who has seen the nest of the Kuaka?" Nor has the egg of this species yet been met with in any of the other countries which it is known to visit.

Limnocinclus acuminatus, *Horsf.*—Sandpiper.

Dr. von Haast having allowed me to examine a specimen of this bird killed at Lake Ellesmere in the month of December, I have been able to add the following description to my former notes on this interesting addition to our avifauna:—

Crown of the head and lores dull rufous; each feather centred with brown; nape, hindneck, and the whole of the mantle brownish-grey, slightly tinged with rufous, each feather largely centred with dark brown, which gradually fades into grey; lower part of back, rump, and upper tail-coverts blackish-brown, slightly margined with rufous; wing feathers dark brown with white shafts, the superior coverts largely tipped, and the secondaries narrowly margined with white; small wing-coverts dull brown with greyish margins; tail feathers blackish-brown, with a narrow margin of fulvous white; line over the eye, chin and throat white; sides of the head dark grey, speckled with brown; the whole of the foreneck fulvous grey speckled with brown, and more distinctly on the outer sides; breast, abdomen, and under tail-coverts fulvous white, the latter with a streak of brown down the shafts; sides of the body, axillary plumes, and inner lining of wings pure white; towards the outer edges of the wing mottled with brown. The outermost upper tail-coverts also are white, with a lanceolate streak of brown down the centre. Bill brown; legs and feet yellowish-olive. Length, 7 inches; wing from flexure, 5·15; tail, 2·15; bill along the ridge, ·95, along the edge of lower mandible, 1·05; bare tibia, ·5; tarsus, 1·1; middle toe and claw, 1·2; hallux and claw, ·8.

Ardetta maculata, *Buller.*—Little Bittern.

All the hitherto recorded examples of the little bittern are from the South Island. But Mr. Colenso assures me that a live specimen was captured by the natives at Tauranga in the year 1836. It was in his possession alive for some time, and he afterwards sent the skin to the Linnean Society. The bird was quite new to the natives in that part of the country.

Nycticorax caledonicus, *Steph.*—Night Heron.

The same informant, in the published article already quoted, supplies evidence of the occurrence of another South Island visitant in this island also. The record (1845) is as follows:—"In crossing a very deep swamp, a beautiful bird, apparently of the crane kind, rose gracefully from the mud among the reeds and flew slowly past us; its under plumage was of a light yellow or ochre colour, with a dark brown upper plumage. None of my natives knew the bird, declaring they had never seen such an one before." It is evident that the bird here referred to is the Nankeen night-heron of Australia, already included among our occasional stragglers.

ANAS SUPERCILIOSA, *Gmel.*—Grey Duck.

In the Bay of Plenty district there are duck preserves which are a source of great profit to the natives and are jealously guarded by them. Rotomahana—a warm lake of little more than half a mile in length—is one of these. From October to February no canoes are permitted on this lake, and no fires are allowed to be lighted in the vicinity. Various kinds of duck breed here in great numbers. From feeding on the small green beetle and on the nahonaho, a stingless gnat which swarms in countless myriads over all the waters in the lake district, the birds become extremely fat; and during the moulting season, which extends over part of February and March, they are incapable of flight owing to the loss of their quills. The strict "tapu" which is enforced during the close season is now removed with great ceremony, and all the population, men, women, and children, start together on a duck-hunting expedition. The men with dogs in short leashes keep within the belt of manuka scrub along the margin of the lake; the women and children proceed to the middle of the lake in canoes, then take to the water, and with great noise and splashing drive the frightened birds up into the bays or inlets, where they seek refuge in the scrub and sedges and are immediately pounced upon by the trained dogs which are still held in leash. The duck-hunter snatches the bird away from the dog, kills it noiselessly by biting it in the head, and then throws it behind him to be collected by a party of women who follow on foot for that purpose. In the season of 1867, seven thousand, it is said, were caught in this manner, in three days, on this lake alone. These were not all grey duck, but included also the black teal (or pochard), the shoveller, and the white-winged duck.

At the Bitter Lake (Rotokawa), in the Taupo district, they are caught in a similar manner. Those that escape the dogs are caught by snares set at night. The snares are placed along the margins of the lake and on the warm stones where the ducks are accustomed to congregate after dark.

At Rotoiti, Rotoehu, and Rotoma, as well as on other lakes in the Bay of Plenty district, Captain Mair has observed that the ducks at one season leave the waters and travel into the surrounding woods. This happens about March and therefore not during the breeding months. Probably they retire for more security during the seasonal moult; for although at other times these lakes fairly swarm with ducks, at this period they are quite deserted. In the woods, however, the dogs turn them up in all directions, He further says:—"It is interesting to watch the ducks feeding on the gnats and green beetles which float on the surface of the warm water, forming a thick scum. On this diet they are always in good condition. The beetles, I may mention, get shaken into the water from the overhanging scrub

by the action of the winds, and the gnats appear to be killed by the sulphurous vapour that rises from the water, and are seen floating on the surface in countless millions."

As a rule the grey duck forms a nest of dry grass or flags, lined with feathers and down plucked from her own body, and selects a convenient situation on the ground—always well-concealed from view—sometimes at a considerable distance from the water. Occasionally, however, a more elevated site is fixed upon. On the famous Island of Motutaiko, in the Taupo Lake, there are some gigantic pohutukawa trees *(Metrosideros tomentosa)*. In the forked branches of these trees, some twenty or thirty feet above the surface of the water, the grey duck often builds her nest and hatches her young. The natives state that when the ducklings are ready to take to the water the old birds bring them down to the lake on their backs.

HYMENOLÆMUS MALACORHYNCHUS, *Gray*.—Blue Duck.

Captain Mair informs me that the wio is plentiful in all the mountain streams in the Urewera country. When marching with the native contingent in pursuit of Te Kooti, as many as forty or fifty were sometimes caught in the course of a day, some being taken by hand, and others knocked over with sticks or stones, so very tame and stupid were they. A pair which he obtained as very young birds at Maunga-pohatu lived in the Kaiteriria camp for two years, associating freely with the domestic ducks, and fairly establishing themselves in the cooking-hut. They were particularly fond of potato and rice, and would readily take food from the hand. Ultimately they took to the lake and disappeared.

LARUS SCOPULINUS, *Forst*.—Mackerel-Gull.

The following communication from Captain Mair (under date May 13) presents this well-known species in the new character of a fruit-eating bird :—" I was greatly surprised on the 1st instant at seeing swarms of the small white gull—tarapunga or akiaki of the natives—crowding on the angiangi trees *(Coprosma)* at the mouth of the Maketu River, eating the berries. They were so tame that I could have knocked them down with my walking-stick. I also saw them in great numbers in the corn-fields at Maketu, and again near Tauranga yesterday. I saw a man ploughing up a grass-field; a flock of three or four hundred of these beautiful little creatures followed his furrow, the horses almost treading on them. They followed in the steps of the ploughman so closely that they seemed almost to settle between his feet. It was a scramble to see who could be first in the furrow after the plough had passed on. A solitary stilt-plover or torea *(Himantopus)* stalked along among them, but at a more respectful distance from the ploughman."

The same correspondent, in connection with this species, has furnished me with another instance of the law of assimilative colouring in eggs for protective purposes. In December, 1875, he visited the Rurima Rocks, in the Bay of Plenty, and found large numbers of *Larus scopulinus* breeding there. In some localities the nests—roughly formed and lined with feathers—were placed in the thick masses of wild spinach or in the midst of "sand-fire." In all such cases he observed that the eggs which these nests contained were splashed over their entire surface with large green blotches, thus assimilating their colour to the surrounding vegetation; whilst other eggs (belonging to the same species), deposited on the white sand in the immediate vicinity, had a totally different appearance, being of a light stone-colour, and so marked as to harmonize exactly with the sandy surroundings.

Stercorarius parasiticus, *Linn.*—Buffon's Skua.

I have to exhibit to the Society another specimen of the skua, or plundering gull (in immature plumage), killed in Wellington harbour in the early part of the present year, and purchased by me from Mr. Liardet. This is the third recorded instance of the occurrence of this species in New Zealand.*

Podiceps cristatus, *Lath.*—Crested Grebe.

I have never met with this species in the North Island, but Captain Mair informs me that he has on two occasions seen it in Waikaremoana Lake in the Urewera country, and once on the Waikareiti, another lake in the same vicinity.

Podiceps rufipectus, *Gray.*—Dabchick.

The following is an interesting fact in connection with the local range of this little grebe which is almost incapable of flight:—

Mount Edgecumbe is a high volcanic cone on the banks of the Rangitaiki River some fifteen miles from the sea. At the bottom of the now extinct crater there is a small pool of water about thirty yards across. In this pool Captain Mair, in 1868, observed three of these dabchicks disporting themselves in the water. Some months after the same number was seen again in the same place by Dr. Nesbitt and Dr. Manley, and again by another party of visitors a considerable time afterwards. There are lagoons at the foot of the mountain frequented by these birds; but the singular fact is that those inhabiting the basin must have climbed up the cone, which is thickly covered on the outside with dense scrubby vegetation, and then down the crater, which contains a heavy forest-growth right down to the edge of the pool.

Captain Mair states that the dabchick is very plentiful in the Hot

* See "Birds of N.Z.," p. 268; and "Trans. N.Z. Inst.," VII., p. 225.

Springs district, and that he has observed as many as a hundred together in Kaiteriria and Rotorua lakes. On their habits, he has furnished me with the following notes:—"In 1869 I was riding along the shores of Tikitapu Lake with H.R.H. the Duke of Edinburgh, when our attention was arrested by a pair of these birds with their young. We drew up and watched them for some time. Taking alarm at our approach, the female took her five young ones on her back and made several dives with them, coming up after each submersion at distances of ten yards or more. The young birds appeared to nestle under the feathers of the parent's back, and to hold on with their bills. In this manner they continued to dive till they were entirely out of sight, and H.R.H. appeared to be much interested in this singular performance."

ART. XX.—*Further Notes on the Ornithology of New Zealand.* By WALTER L. BULLER, C.M.G., Sc.D., F.L.S.

[*Read before the Wellington Philosophical Society, 12th January,* 1878.]

CIRCUS GOULDI, *Bonap.*—Harrier.

IN the "Birds of New Zealand," page 15, I have described a very beautiful albino specimen obtained by Mr. Goodall at Riwaka, and preserved in the Nelson Museum. During a visit to the Lake district last year I saw another, apparently very like it, hovering over the fern ridges that close in the intensely blue waters of Tikitapu. As he swooped down upon a rat or lizard in the fern, his under-parts appeared to be perfectly white, and the upper surface of the body and wings ashy.

HIERACIDEA FEROX, *Peale.*—Sparrow-hawk.

A pair of these birds bred for two successive seasons on a rocky crag at Niho-o-te-kioro. They guarded their nest with great vigilance, fiercely attacking all intruders.

I may mention that this species, unlike the generality of hawks (so far as I am aware), may be attracted by an imitation of its cry. Riding along alone one fine autumn evening through the country at the northern end of Lake Taupo on my way to Ohinemutu, I saw what appeared to be a sparrow-hawk come out of the bush at some distance and descend into an old or deserted Maori garden. By way of experiment I imitated the clamorous cry of this bird when on the wing; and in a few minutes the hawk (a fine young male) came sailing up to me and performed several circuits in the air immediately overhead, and then took up his station on the dry limb of a tree close by the road, where he remained till I was out of sight.

Platycercus novæ-zealandiæ, *Sparrm.*—Red-fronted Parrakeet.

The Hon. W. Fox, who has just returned from a trip through the Canterbury district, informs me that the farmers have suffered this season a visitation, tens of thousands of these birds having descended on their ripening crops of corn and proved almost as destructive as an army of locusts. It is difficult to account for these occasional irruptions in such numbers, in the case of a bird not otherwise plentiful.

Stringops habroptilus, *Gray.*—Owl Parrot.

Until within the last few years the kakapo abounded in the Urewera country, and the natives were accustomed to hunt them at night with dogs and torches. The Maori proverb, "Ka puru a putaihinu" relates to the former abundance of this bird. The natives say that the Kakapo is gregarious, and that when numbers of them congregated at night their noise could be heard to a considerable distance. Hence the application of the above proverb, which is used to denote the rumbling of distant thunder.

It is said that the kakapo is still abundant on the wooded ranges of the Kaimanawa, in the Taupo district.

Halcyon vagans, *Less.*—New Zealand Kingfisher.

Reverting to an old controversy between Captain Hutton and myself,* in which I maintained the piscivorous habits of our kingfisher, under certain conditions, I may add to the argument the following note lately received from Captain Mair:—"The kingfisher is found in all the mountain streams of the Urewera and Bay of Plenty districts. It subsists largely on small fresh-water fish (mohiwai of the natives), also on flies, moths, and beetles. Referring to your interesting account of its nesting habits in the 'Birds of New Zealand,' I may mention that I have found three or four pairs building in close association in a clay bank, and that on one occasion I counted ten pairs boring in the standing trunk of a dead and decaying rimu. I have never found more than five eggs in a nest."

Zosterops lateralis, *Reich.*—Silver-eye.

I have lately had an opportunity of examining a beautiful series of the nests of this species, and through all the variety of individual form and structure they preserve two essential features—namely, the large cup-like cavity with thin walls, and the admixture of long hairs in the lining material. I have already mentioned † the circumstance of pigs' bristles being pressed into the service in a part of the country not much frequented by horses or cattle; and in one of the nests forming the above series, the proximity to civilization was proclaimed by a lining consisting of the flaxen hair from a child's doll!

* "The Ibis," Jan., 1874, "Trans. N.Z. Inst.," VI., p. 129.

† "Trans. N.Z. Inst.," VIII., p. 183.

The history of the first arrival of this pretty little bird in the North Island in 1856 is too familiar to need repeating. It was several years before it became acclimatized, but once fairly established amongst us, it has continued to increase and multiply, and now it disputes possession of our gardens and hedgerows with the introduced sparrows and finches, and swarms all over the country. In the Bay of Plenty district it is said to be particularly plentiful, so much so as to form an article of food to the natives. They are in season in the months of March and April, and are then collected in large numbers, singed on a bush fire to take the feathers off, and forthwith converted into *huahua* and potted in calabashes. The catching is effected in a very primitive way. The birds have their favourite trees upon which they are accustomed to congregate. Selecting one of these, the bird-catcher clears an open space in the boughs and puts up several straight horizontal perches, under which he sits with a long supple wand in his hand. He emits a low twittering note in imitation of the birds' and, responding to the call, they cluster on the perches, filling them from end to end. The wand is switched along the perch, bringing dozens down together, and a boy on the ground below picks up the stunned birds as they fall. Captain Mair, when visiting Ruatahuna on one occasion, had brought to him, by two Urewera lads, a basket containing some five or six hundred of these little birds which had been killed in the manner described.

In front of the Rev. Mr. Spencer's house at Tarawera, in a hedge of *Laurustinus*, scarcely six yards from the door, upwards of twenty nests of *Zosterops* were found at one time, each containing from three to five eggs (generally the former) of a lovely blue colour. Usually, however, these birds do not breed in communities but scatter themselves in the nesting-season.

MYIOMOIRA TOITOI, *Reich.*—Pied Tit.

This familiar little bird, the "Tomtit" of the colonists, is far less plentiful than it formerly was in our fields and gardens. There seems no reason to fear, however, that the species is dying out, for in the *Fagus* forests of the interior I have found it extremely plentiful. In the woods at the foot of Ruapehu and neighbouring high lands, where, save the occasional twitter of small birds in the branches, all is silent as the grave, this pretty little creature is always to be met with. It flits noiselessly from one tree to another, then descends to the ground, and in a few instants reappears on its perch, flirting its tail upwards, and emitting at intervals a soft, trilling note of exquisite sweetness. Destitute of animal life as these sub-alpine woods undoubtedly are, they are not without their attractions. Owing to their high elevation vapour-clouds are continually hanging over them, causing a perpetual moisture. In consequence of this the trees on

their outer facies are more or less covered with kohukohu, a feathery fungus of a pale green colour, hanging like drapery from the branches, while their trunks and limbs are clad to their very tops with the richest profusion of lichens and mosses. The underwood is one mass of cryptogams, and the very ground is carpetted with beautiful mosses. No idea can be formed of the quasi-tropical richness of these woods in this respect by any one who has not actually visited them. On the outskirts small flocks of *Zosterops* consort together in the underwood, and a few flycatchers and whiteheads share the solitude with the sober tomtit; but as we enter the woods the stillness becomes oppressive, unbroken even by the chirp of a cricket or the drumming of a locust, and the only sign of animation is an occasional night-moth lazily flapping its wings in the gloomy shade of the forest.

Sphenœacus punctatus, *Gray.*—Common Utick.

During my recent visit to the Lake district, I found this little bird plentiful in all suitable localities. In the marshy tracts occurring at intervals along the road from Taupo to Ohinemutu its familiar note was the only animate sound in those quiet solitudes; and it was always pleasant to hear a pair of them singing a duet, their plaintive notes being always in harmony and responsive.

Creadion carunculatus, *Gmel.*—Saddle-back.

This species is very irregular in its distribution. I have endeavoured to describe its range in my "Birds of New Zealand." I omitted, however, to mention that in one locality north of Auckland—a small wood at Kaitaia called Mauteringi, some three or four miles in extent—this bird is comparatively plentiful, although rarely ever met with in other parts of that district. Although never seen in the Bay of Plenty woods, it is numerous enough in the Ngatiporou country, where the natives regard it as a bird of omen. A war party hearing the cry of the tieke to the right of their path will count it an omen of victory, but to the left a signal of evil. It is also the mythical bird that is supposed to guard the ancient treasures of the Maoris. The relics of the Whanauapanui tribe—*mere pounamus* and other heir-looms of great antiquity and value—are hidden away in the hollow of a tree at Cape Runaway, and it is popularly believed that the tieke keeps guard over these lost treasures. According to Maori tradition, among these hidden things is a stone *atua*, which possessed at one time the faculty of moving from place to place of its own accord, but has since become inactive.

The natives state that this species usually places its nest in the hollow of a tree, and they point to holes in well-known trees where the tieke has reared its young for many years in succession. A pair is said to be

still breeding in the hollow of the famous tree at Omaruteangi, known all over the country as "Putatieke."* The bird is accordingly regarded with some degree of superstitious reverence by the Arawa, who will not allow it to be wilfully destroyed. Those who have read Maori history will be familiar with the story of Ngatoroirangi and his sacred tiekes of Cuvier Island. Hence the proverb, "Manu mohio kei Reponga," commonly applied to a man wise in council, and used in the sense of our own proverbial saying "Old birds are not to be caught with chaff."

As the question of the specific value of *Creadion cinereus* is still unsettled, it may be mentioned here that Captain Mair, who has been familiar with the bird for years, has never seen one in the plumage of the so-called *cinereus*, supposed at present to be the immature state of *C. carunculatus*. If this form is in reality the young of the ordinary species, it is astonishing that it has never yet been met with in the North Island, although common enough in the South.

Glaucopis wilsoni, *Bonap.*—Blue-wattled Crow.

During the autumn months this bird is comparatively plentiful in the Mangorewa forest between Tauranga and Rotorua. The traveller at this season frequently meets with it hopping about along the road or among the bushy branches of *Solanum* on either side.

There is a fine albino specimen in the Colonial Museum, obtained in the Rimutaka ranges and presented by Mr. G. Elliotte, who had it alive for several months.

Porphyrio melanotus, *Temm.*—Swamp-hen.

I have before mentioned that the swamp-hen is one of those native species that increase with the progress of settlement. This is very noticeable in many of our farming districts. Captain Mair informs me that at Whangarei (north of Auckland), during a period of fifteen years—from 1850 to 1865—he never saw one in that district. After that date they began to make their appearance, and now they are comparatively plentiful, being met with in flocks of twenty or thirty together. In the Lake district they are everywhere abundant. At the warm lake of Rotomahana several hundreds may be seen in a single flock. They build their nests on the silica terraces, not in groups or colonies, but singly and without much attempt at concealment. Captain Mair has found as many as fourteen eggs in one nest, and eleven in another. At Tokano (at the southern extremity of Lake Taupo) the natives snare thousands of them in June and

* *Putatieke*: A renowned hinau tree in the Urewera country. It is supposed to possess miraculous attributes. Sterile women visit it for the purpose of inducing conception. They clasp the tree in transport, and repeat certain incantations by way of invoking the *atua*.

July, at which time they are very fat. They are caught by a very simple artifice. The natives, having marked their principal haunts, drive rows of stakes into the swampy soil at distances of a few feet. These are connected by means of flax-strings, from which are suspended hair-like nooses (made of the fibrous leaf of *Cordyline*) arranged in close succession, with the edges overlapping, and placed just high enough from the ground to catch the bird's head as it moves along the surface in search of food. As the swamp-hen is semi-nocturnal in its habits, being most active after dusk, it has less opportunity of avoiding the treacherous loops. It frequents the Maori plantations in considerable numbers and proves very destructive to the young crops, and later in the season it plunders the potato fields and kumera beds. The snaring of these birds, therefore, on this large scale, answers a double purpose, inasmuch as they are excellent eating when roasted in their own fat. Their eggs also are much sought after in the nesting season, being esteemed as great a delicacy as "plover's eggs."

Himantopus novæ-zealandiæ, *Gould*.—Black Stilt.

This species, as well as the pied stilt, is very plentiful in the Lake district. They appear to subsist chiefly on the dead gnats that float on the surface of the water in the sulphur springs. The plovers are continually to be seen wading about in the warm yellow water of these springs, feeding on the floating scum and on the small salamander worms which abound in these places.

Anarhynchus frontalis, *Quoy et Gaim*.—Wry-billed Plover.

This very peculiar bird with an asymmetrical bill is tolerably common in the Bay of Plenty. They associate freely with the flocks of godwit on their feeding-grounds and resting-places during the alternation of the tides.

Ardea syrmatophora, *Gould*.—White Heron.

This stately bird appears so rarely in the North Island that the natives distinguish it as "the bird seen once in a life-time." In the summer of 1865 a pair visited the Mangrove Swamp at Whangarei, and remained there several weeks. The year before a pair was seen in Whangape Lake in the Lower Waikato; in 1867 another pair frequented, for some time, the marshy ground at the mouth of the Maketu River, and again in 1867 a pair visited the banks of the Waihi in the same district. The natives made every possible effort to obtain these birds for the sake of the white plumes. In both of the last-mentioned cases they succeeded in killing one of them, the survivor remaining in the locality for several months, leaving only on the approach of winter.

Ardea sacra, *Gmelin*.—Blue Heron.

A pair was seen by Captain Mair on the Taupo Lake in October, 1875. It is tolerably common along the shores of the Bay of Plenty.

CASARCA VARIEGATA, *Gray.*—Paradise Duck.

This fine duck is seldom met with north of Petane. A flock of five visited Rotomahana Lake in March, 1866, and a pair was seen in Lake Taupo in October, 1878. I have already recorded* the appearance of five some years ago in the Kaipara district, at the far north. These are the only instances that have come within my knowledge of the occurrence of this species beyond its ordinary range.

STERCORARIUS ANTARCTICUS, *Gray.*—Southern Skua.

In my "Birds of New Zealand," page 267, I mentioned the only local specimen then known—a female bird obtained by Dr. Hector in Woodhen Cove, on the south side of Breaksea Sound, and deposited in the Otago Museum. Other specimens have since been collected in the South Island, and I have now in my possession a living example taken some months ago at Waikanae, some forty miles from Wellington.

LARUS DOMINICANUS, *Licht.*—Black-backed Gull.

Simpkins, a publican at Whakatane, obtained a female of this species, when quite young, from White Island, a distance of some thirty-five miles. It became perfectly tame, answering to the name of "Hinemoa," and coming into the house at meal-times to be fed. When about two years old it suddenly disappeared, and after a lapse of six months it returned with two young ones, which have since become quite domesticated. By last advices both old bird and young were still inhabitants of the yard, and evinced no desire to leave it.

PROCELLARIA PARKINSONI, *Gray.*—Black Petrel.

This petrel is said to breed in large numbers on the Island of Karewa, in the Bay of Plenty. In March the Maoris visit the island and collect the young of this and other species. The most plentiful, however, is the oii or mutton-bird (*Puffinus tristis*).

PHALACROCORAX BREVIROSTRIS, *Gould.*—White-throated Shag.

In the Lake district there are "shaggeries" of considerable magnitude which are much valued by the natives, each colony of nests having its own proprietor, who exercises all the rights of ownership, visiting the ground at the breeding season for the purpose of collecting the young birds, which are potted in the usual manner and are considered a great dainty. Captain Mair accompanied one of the shag parties to the Tauranga River, at Lake Taupo, and saw 400 young birds collected in the course of a single day. Both the white-throated and the small black shag breed together in these localities, although apparently never pairing. Captain Mair still adheres

* "Birds of New Zealand," p. 242.

to the opinion that they are distinct species, and has promised to send me nestlings of both for comparison.

It will be remembered that at one of our meetings in 1875,* I exhibited an adult bird, supposed to be of this species, in which there were indications of a seasonal change of plumage from a rusty or brownish to a glossy black, without any appearance of white on the throat or fore-neck.

Phalacrocorax varius, *Gmel.*—Pied Shag.

Captain Mair informs me that at a place called Whakarewha, near Matata on the East Coast, there is a colony of the white-bellied shag where thousands of them breed together. The nests are crowded together on the branches of a clump of pohutukawa trees growing on the cliff; and the old birds may often be seen fighting fiercely for the possession of a dry stick or piece of sea-weed, required for building purposes, or endeavouring to dispossess each other of nests already made. In these fights the young birds are not unfrequently knocked out of the nests, and numbers of dead ones are found lying on the beach at the base of the cliff. The nests are rude structures formed of dry twigs and sticks, bound together by means of a peculiar kind of kelp for which the shags may be observed diving in the sea, sometimes in four fathoms of water. The harrier (*Circus gouldi*) hovers about this breeding-place and makes an occasional attempt to carry off a young bird from the nest by boldly attacking it; whereupon numbers of the old birds sally forth with loud guttural cries and chase the intruder to a considerable distance.

Captain Mair, who has often visited this "shaggery," says:—"It is very amusing to watch the old birds feeding the young ones. With a slow flapping of its ample wings the parent bird comes in from her fishing excursion, her capacious throat distended with food. There is much excitement in the nest on her approach. The young birds open wide their mandibles, and thrusting her beak down the throat of her offspring, the careful mother empties the contents of her pouch right into the little one's crop. All this time the delighted recipient is swaying its body to and fro, vibrating its flippers and uttering a perpetual scream of joy."

At the Rurima Rocks in the Bay of Plenty, six miles from the shore, where some three or four hundred shags congregate every year to refit their nests in the tall pohutukawa trees, the birds are almost exclusively of this species.

Phalacrocorax novæ-hollandiæ, *Steph.*—Black Shag.

Captain Mair states that this species is rarely seen in the Bay of Plenty. But he distinguishes from this what he terms the "Large Brown River

* "Trans. N.Z. Inst.," VII., page 225.

Shag," the mapo or matapo of the Maoris. He describes this bird as "brown all over with a yellow tinge on the throat," and says that it frequents lakes and the upper courses of rivers and is never met with on the sea coast. A colony of them, numbering about a dozen individuals (exclusively of this kind) breed every year in a kahikatea forest near the shores of Lake Rotorua.

APTERYX AUSTRALIS, *Shaw.*—South Island Kiwi.

Comparatively few specimens of this bird are now brought in by collectors in the South Island, whereas the supply of *Apteryx oweni* is undiminished.

APTERYX MANTELLI, *Bartl.*—North Island Kiwi.

The natives whom I found camping at the foot of the Kaimanawa range in March last assured me that the kiwi was still very plentiful there. About a fortnight before the date of my visit (or end of February) they captured a female with a well-grown young one in a hollow log. It may be inferred therefrom that this species commences nesting about the beginning of January. As the natives agree that there is never more than one young bird in the nest, it seems probable that the kiwi breeds twice during the season.

ART. XXI.—*On the Disappearance of the Korimako* (Anthornis melanura) *from the North Island.* By WALTER L. BULLER, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 22nd September, 1877.*]

IN my "History of the Birds of New Zealand," in treating of this bird I made the following statement, which was afterwards challenged by Captain Hutton, in a communication to "The Ibis :"—

"This species, formerly very plentiful in every part of the country, appears to be rapidly dying out. From some districts, where a few years ago it was the commonest bird, it has now entirely vanished. In the Waikato it is comparatively scarce; on the East Coast it is only rarely met with; and from the woods north of Auckland it has disappeared altogether. In my journeys through the Kaipara district eighteen years ago, I found this bird excessively abundant everywhere; and on the banks of the Wairoa the bush fairly swarmed with them. Dr. Hector, who passed over the same ground in 1866, assures me that he scarcely ever met with it; and a valued correspondent, writing from Whangarei (about eighty miles north of Auckland), says :—'In 1859 this bird was very abundant, in 1860 it was less numerous, in 1862 it was extremely rare, and from 1863 to 1866 I never saw but one individual. It now seems to be entirely extinct in this district.'"

Captain Hutton, in the communication referred to,* suggested that the districts in which the bird was all but exterminated were only those thickly inhabited by Maoris, to which the obvious reply was that the extensive wooded district lying between Whangarei and the North Cape is not inhabited by Maoris at all. Dr. Hector, who made a geological survey of that district in 1868, did not meet with a single korimako, whereas formerly these birds existed there by thousands. My remarks on the present scarcity of the species were intended to refer principally to the North Island, but even in the South, as I have already pointed out ("Trans. N.Z. Inst.," vol. IX., p. 330), it is far less plentiful than it formerly was. Doubtless it is only a question of a few years, and the sweet notes of this native songster will cease to be heard in the grove, and naturalists, when compelled to admit the fact, will be left to speculate and argue as to the causes of its extinction.

My observations as to the extreme rarity of this species in the North Island, where in former years it was the commonest of the perchers, are confirmed by Captain Mair, who informs me that during the last eight years he has never met with it at all, except on the Island of Mokoia (a place of some historic interest in the Rotorua Lake, about 600 acres in extent), and in a tract of manuka bush covering about a thousand acres of land at the foot of Mount Edgecumbe. In both of these localities it is still very plentiful.

In 1868, Captain Hutton found the korimako abundant on Great Barrier Island, although even then scarce on the main-land;† and in 1871 Major Mair met with it on the Rurima Rocks and on Whale Island, in the Bay of Plenty, places about five miles apart. He records the delight with which he again listened to its sweet note, and adds, "the Maoris think that it is the sole survivor of the race, and that it flies backwards and forwards between these islands." ‡

Although I have travelled a good deal through the forests of the interior since my return from Europe in 1874, I have positively never met with a single example of this bird on the main-land; but during a storm-bound visit to the island of Kapiti, in April last, I was charmed immediately on landing to hear the musical notes of the bell-bird again, and to meet with it in every direction among the stunted karaka groves that clothe the western slopes of the island. In the course of an afternoon I saw a score or more of them within a very limited area, and on a second and more extended visit on the following day I found them equally numerous. I met with another bird

* See "Ibis," January, 1874. † "Trans. N.Z. Inst.," I., p. 161.
‡ "Trans. N.Z. Inst." V., p. 152.

also, which has likewise become well-nigh extinct on the main-land (*Miro longipes*), although not in such numbers as the former.

The facts I have mentioned are interesting as furnishing another illustration of the observed natural law, that expiring races of animals and plants linger longest and find their last refuge on sea-girt islands of limited extent.

ART. XXII.—*Further descriptive Notes of the Huia* (Heteralocha acutirostris.)

By WALTER L. BULLER, C.M.G., Sc.D.

Plate V.

[*Read before the Wellington Philosophical Society, 17th November*, 1877.]

HETERALOCHA ACUTIROSTRIS, *Buller*.—"Birds of New Zealand," pp. 63–68.

To the full account which I have already published of this rare species, I wish to add the following notes:—

Young female.—Differs from adult bird in having the entire plumage of a duller black, or slightly suffused with a brownish tinge and with very little gloss on the surface. Under tail-coverts tipped with white, and the terminal white bar on the tail washed with rufous-yellow—especially in the basal portion. Wattles small and pale-coloured. Bill only slightly curved, as represented in fig. 1.

In another specimen in my possession, apparently a year older, the tail-coverts are without the margin, the white on the tail-feathers is purer, and the bill is perceptibly longer, with a darkened tip.

Young male.—In comparing a specimen received at the same time with the above, the same general remarks apply, except that the under tail-coverts are not tipped with white at all, while the soft feathers on the lower part of the abdomen are largely tipped with pale rufous and white. The pale rufous wash on the tail-bar is likewise more conspicuous. The bill presents the outline shown in fig. 2.

For purposes of comparison I have reproduced in the accompanying plate (fig. 3) my former drawing of the bill in the fully-developed female. Fig. 4 represents a curious deformity, if it may be so called, in a specimen which recently passed through my hands. The lower mandible having been at some time accidentally broken off, the upper mandible had considerably overgrown it, becoming somewhat thickened beyond the point of friction.

ART. XXIII.—*On the Egg of the Huia* (Heteralocha acutirostris). By WALTER L. BULLER, C.M.G., Sc.D.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

IN a paper read before this Society last year,* I described, as a great novelty, the egg of the huia, from a specimen (containing a well-developed embryo) obtained by Mikaera in the Wainuiomata bush. The same native brought in to me this season another huia's egg obtained in the same locality. It differs so much in appearance from the one in the Colonial Museum as to create a doubt at first sight of their identity. Mikaera, however, stoutly affirms that he is right; and on proceeding to blow the egg I found the shell extremely thin and fragile, agreeing in this respect with the one already described. The present specimen is more elliptical in form, measuring 1·8 inches in length by 1·1 in its widest diameter. It is of a very delicate stone-grey, inclining to greyish-white, without any markings except at the larger end, where there are, chiefly on one side, some scattered rounded spots and dots of dark purple-grey and brown. Towards the small end there are some obsolete specks, but over the greater portion of its surface the shell is quite plain.

The egg when brought to me was perfectly fresh, and the native declares that he took it from the ovary of the bird just as it was ready for extrusion. This may perhaps account, in some measure, for the extreme delicacy of the shell, which fractured under the gentlest handling in blowing, as well also for the absence of markings. I see no reason to doubt the authenticity of the specimen, for any one who has taken the trouble to examine and compare the eggs of the common house-sparrow will be aware how much the eggs of some species differ from each other in this respect, even those taken from the same nest; and we have no sufficient data at present for determining the extent of variability in the eggs of this rare form.

Mikaera brought this specimen to me on or about the 11th October. The egg previously described, which was apparently within a day or two of hatching, was obtained about the 20th October. These dates will therefore give approximately the period of incubation.

The Museum specimen (which I am permitted to exhibit this evening for comparison) measures 1·45 by 1·05 inches, and is of a pale stone-grey, irregularly stained, freckled, and speckled with purplish-grey, the markings in some places running into dark wavy lines.

* "Trans. N.Z. Inst.," VIII., p. 192.

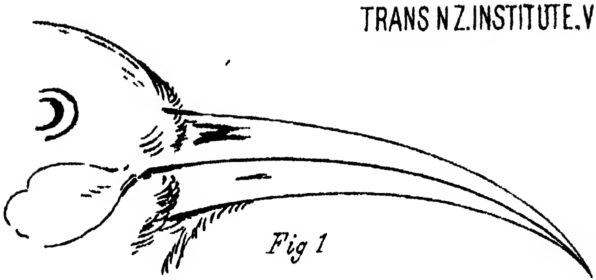


Fig 1

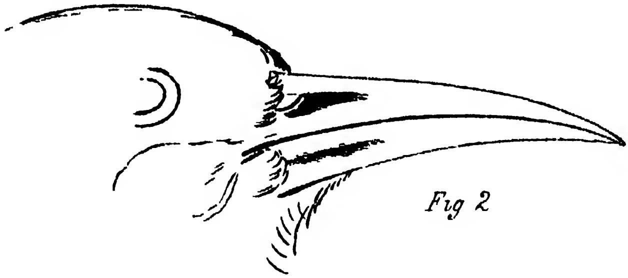


Fig 2

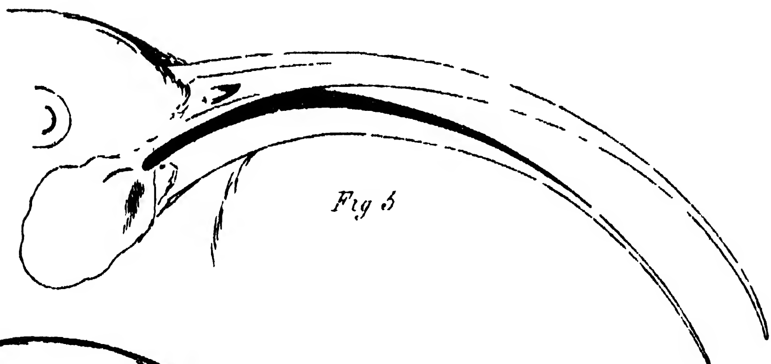


Fig 3

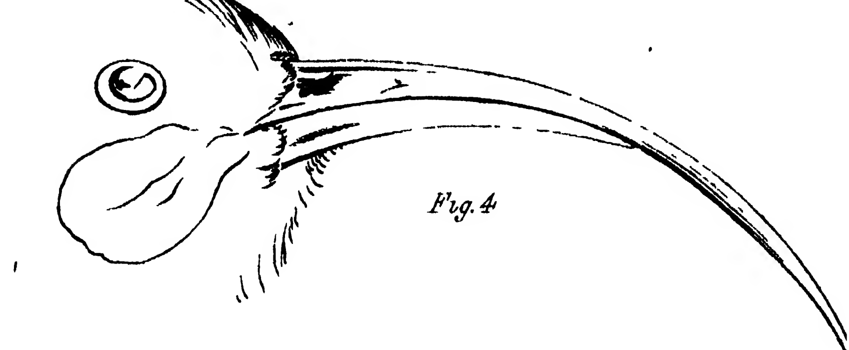


Fig. 4

HEADS OE HUIA.

To illustrate Paper by Dr Buller.

W.L.Buller, del.

Art. XXIV.—*On the Species forming the Genus* Ocydromus, *a peculiar Group of brevi-pennate Rails.* By Walter L. Buller, C.M.G., Sc.D., F.L.S.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

Although as a group the limits of the genus *Ocydromus* are sufficiently well defined, considerable difficulty has been experienced in determining the species. Every naturalist who has studied the subject appears to have arrived at some different conclusion as to the number of constant forms; and where the variances as to size and plumage are so well maintained it is difficult to avoid drawing specific distinctions. If, however, it can be shown that all these extreme forms graduate in a series, or, in other words, run into one another, it becomes impossible to find any fixed aberrant characters. Without professing to be able yet to place the matter beyond all dispute, I venture to think that the series of specimens which I have the honour to exhibit this evening affords pretty strong evidence that several of the so-called species in the South Island must be united under the name of *Ocydromus australis.*

In my "Birds of New Zealand," I admitted only three well-ascertained species as inhabiting New Zealand—namely, *O. earli*, *O. australis*, and *O. fuscus.* I mentioned in the introduction to that work that, although Dr. Finsch recognized a fourth (*O. troglodytes*, Gmel.), I was unable to draw any specific line. Nevertheless, I pointed out very fully, in my account of the South Island wood-hen, the great variation both as to size and markings which that species exhibits, especially among birds from different localities.

Captain Hutton, in an article on the New Zealand Wood-hens, read before this Society* in September, 1873, agreed with Dr. Finsch in admitting *O. troglodytes*, and added two more species of his own under the names of *O. hectori* and *O. finschi.* He further described a "variety or immature" example of this last-named species, which he suggests may "possibly be identical with *Gallirallus brachypterus*, Lafr."

Dr. Finsch, in a paper† written the year following, professes to identify *Ocydromus troglodytes* with the *O. australis* of my text, page 170, but not the plate; of *O. hectori* he remarks, "I consider this a good species after having compared a typical specimen;" and of *O. finschi* he says that, having examined the type, he considers it a good species, although not without some suspicion that it may prove to be a variety of *O. fuscus.* He confuses *Ocydromus australis*, Sparrm., with the well-known *O. earli*; and with respect to the latter in Hutton's list, he makes the following singular statement:—"Dr. Buller, in his great work, unfortunately does not mention

* "Trans. N.Z. Inst.," VII., p. 110. † "Trans. N.Z. Inst.," VII., p. 226.

the typical specimen of *O. earli*, Gray, and not having compared it myself, I am unable to make out whether the true *earli* is, indeed, the bright cinnamon-red bird as Captain Hutton and I believe, or whether it is the same as *O. australis*, figured under the name of *earli* by Dr. Buller."* Captain Hutton, on the other hand, writes me:—"I am sure that you are right about the identification of *O. earli*, and I don't understand how Finsch thinks otherwise."†

Baron A. von Hügel, who has lately been on a scientific tour through the colonies, writes thus in "The Ibis"‡:—"Of New Zealand things I have got a very fair collection—some 800 specimens already. *Ocydromus* I have, of course, gone in for, and have a lot of notes about it. I don't believe in more than three good species — *O. australis* (with endless varieties), *O. fuscus*, and *O. earli*. The last two are difficult to procure, although I shall doubtless get a series of the latter in the North Island; but of *O. australis* one could get a shipload in a very short time. I have got a splendid series, showing every age from embryo to adult, and varieties to perfection."

It will be seen, therefore, that the Baron, who comes to the subject with a totally unprejudiced mind, adopts my published division of the species in a very positive manner.

If, on further investigation, it should be found necessary to add a fourth species, this must be *Ocydromus brachypterus*, Lafresnaye; for Dr. Finsch, who appears to have examined the type specimen, affirms distinctly§ that it is the same as Hutton's *O hectori*; and Captain Hutton himself admits that this is "very probable."‖ This is of course the bird referred to at page 171 of my "Birds of New Zealand" in the following passage:—"Dr. Hector informs me that on all the high mountains of the Otago province he met with a 'cream-coloured variety,' conspicuously marked and very readily distinguishable from the common bird. Mr. Buchanan confirms this observation, and states that on the Black Peak, at an elevation of 6,000 feet, he found this light-coloured variety very abundant, but none of the other birds; the former indeed were so numerous as to prevent his getting any

It seems unfortunate that in obedience to the law of priority in nomenclature, we must sink a name, very fittingly bestowed, in favour of *brachypterus*, which expresses no distinguishing specific character, being equally appropriate to all the forms of *Ocydromus*.

* "Trans. N.Z. Inst.," VII., p. 231. † *Ib.*, IX., p. 330.
‡ "The Ibis," July, 1875, p. 393. § "Trans. N.Z. Inst.," VIII, p. 202.
‖ "Trans. N.Z. Inst.," IX., p. 330.

OCYDROMUS EARLI, *Gray*.

This is the North Island species, very distinct in character from the others and exhibiting only a slight degree of individual variation. It is admirably figured by Keulemans, and a full description of it, in all stages, is given in my "Birds of New Zealand" (pp. 165, 166).

OCYDROMUS AUSTRALIS, *Sparrm*.

This species has never been met with in the North Island as an indigenous bird, although of late years it has been successfully acclimatized by Sir George Grey at Kawau.

The tendency of this bird to vary, in a very remarkable degree, has occasioned much difficulty in discriminating the form.

In my published account of *O. australis** I made the following observations on this point:—"Examples from different localities exhibit so much variety in size and plumage as to suggest the existence of another closely allied species. Mr. Potts says that when he was 'camping in one of the gorges of the Rangitata a very striking variety used to visit his tent constantly; the individuals of either sex were above the average size; the general colour of the plumage light greyish-brown, the feathers barred or marked with shades of dark brown; the rump, and in some instances the tips of the primaries, rich chestnut; throat and cheeks grey.' * * * * My brother, Mr. John Buller, assures me that he invariably found the alpine bird considerably larger than those inhabiting the plains and of a much lighter colour. A specimen brought by Mr. Henry Travers from the interior of the Marlborough province has the general plumage of a yellowish-buff colour, very obscurely marked and spotted with brown; and among those obtained by Sir George Grey in the Otago hills for the purpose of stocking the Kawau Island, I observed that one (apparently a young bird) had similar plumage, although it was more distinctly banded on the sides and flanks. Sir George Grey informed me that these birds were taken by himself at an elevation of 6,000 feet, where they were found concealed under the tussocks or hiding among the loose rocks, the assistance of a dog being required to dislodge them." I further described a specimen in my own collection in which the whole of the upper surface is light fulvous shaded with brown, each feather having a sub-terminal spot of that colour; the primaries and secondaries are dark rufous-brown barred with black, and the soft overlapping feathers are fulvous, stained more or less with rufous and barred with black in their middle portion, margined and spotted towards the end with cream-yellow; the throat, fore-neck, and breast pale cinereous brown, mixed with fulvous on the crop; the lower parts dull

* "Birds of N.Z.," pp. 170–178.

cinereous brown, fasciated on the sides and flanks with narrow markings of fulvous.

After fully describing the ordinary plumage of the adult male, I stated that the female was smaller, with darker plumage and duller coloured legs; and that in immature birds the tints of the plumage generally are lighter, the transverse markings are less distinct, and the colours of the bill and legs are paler; the irides are dark brown; there is less rufous on the head and often considerably more of the cinereous grey colour on the breast and abdomen.

Ocydromus fuscus, *Dubus.*—Kelp-hen.

An apparently adult female specimen of this bird in the Canterbury Museum (obtained at Preservation Inlet) has the general plumage brownish-black; throat dark grey mixed with smoky-brown; the plumage of the fore-neck, lower hind-neck, and upper surface of wings presenting dull streaky marks of rufous, each feather being irregularly touched with this on each web; tail-feathers black; under coverts obscurely marked with rufous. On the under face of one of the primaries (an old feather which came out on being handled) there are obsolete rufous bars; and the scattered new feathers appearing on the upper surface of the body are almost entirely black; bill, bright reddish-brown at the base, horn-grey towards the tips of both mandibles; legs and feet reddish-brown.

It may be inferred from this state of plumage that the tendency of this species is to darken towards maturity. I have not yet had an opportunity of examining a first year's bird, but, judging by analogy, I think Captain Hutton is probably right in his conjecture that his "*O. finschi* is only the young of *O. fuscus.*"*

Dr. Finsch himself † expressed the suspicion that one was a variety of the other.

Ocydromus sylvestris, *Sclater.*

This is a very distinct species inhabiting Lord Howe Island. There were too living examples in the Gardens of the Zoological Society when I last visited them in 1873.

Ocydromus lafresnayanus, *Verr. et Des Murs.*

This form is peculiar to New Caledonia. The Zoological Society received a live specimen from Dr. Geo. Bennett in June, 1869, and another from the same donor in May, 1873.

* "Trans. N.Z. Inst.," IX, p. 331. † "Trans. N.Z. Inst.," VII, p. 232.

ART. XXV.—*Notice of the Occurrence of the Shy Albatros* (Diomedea cauta) *in the North Island.* By WALTER L. BULLER, C.M.G., Sc.D., F.L.S.

[Read before the Wellington Philosophical Society, 22nd September, 1877.]

IN a paper on New Zealand Ornithology which I had the honour of reading before this Society in September, 1876, I mentioned, on the authority of Captain Hutton, that a specimen of the shy albatros *(Diomedea cauta)* had been obtained at Blueskin Bay in Otago, thus adding a sixth species to the list of albatroses inhabiting our seas. I have now much pleasure in exhibiting another specimen of this fine bird, which was captured on the beach near the Wellington pilot station on the 12th July, and brought to me alive by Mr. James A. Capper of Molesworth Street. The fishermen by whom it was caught informed him that it had apparently been shot at sea and allowed to float ashore, the right wing being completely disabled, but that they had nevertheless considerable trouble in overtaking it before it reached the water.

This example proved on dissection to be a female, and as I have not before had an opportunity of examining this rare species in a fresh state, I think it is desirable to place on record in our "Transactions" a full description of it.

Fem. ad.—Fronte et vertice cinerascenti-albis: pileo colloque totis pulchrè cinereo lavatis: regione ante- et super-oculari cinerascenti-nigris: dorso et interscapulio cum alâ totâ cinerascenti-nigris: uropygio, supracaudalibus albis: remigibus brunnescenti-nigris, scapis ad basin flavicanti-albidis, secundariis versùs apicem brunnescentè tinctis; caudâ saturatè argentescenti-cinereâ, scapis albidis: subtùs purè albus: subalaribus albis, plumis exterioribus nigricantibus: iride læto vinascenti-brunneâ: pedibus sordidè corneo-albicantibus, tarsis saturatioribus: rostro cyanescenti-corneo, ad apicem sordidè nigro, culmine medialiter et gonyde obscurè flavicantibus, ad basin conspicuè nigro marginatis: margine ad basin mandibulæ læte flavâ.

Adult Female.—The whole of the head and neck delicate pearl-grey, shading off almost to white on the crown and forehead; lores and a line over each eye greyish-black, shading off below into the pearl-grey; back and upper surface of wings greyish-brown; rump, tail-coverts, and the whole of the under parts pure white, softly blending with the grey on the lower foreneck; quills brownish-black, the shafts whitish horn-colour towards the base, the longer secondaries tinged with sepia-brown; tail-feathers dark silvery-grey, with white shafts, and paler on the under-surface; lining of wings white, some of the feathers towards the edge of the wing greyish-black; irides rich vinous brown; feet dull fleshy white, the tarsi darker;

bill bluish horn-colour, lighter and tinged with yellow along the culmen, and also on the under surface of the lower mandible; the sides of the unguis or hooked extremity, as well as the terminal expansion of the lower mandible, dull black; the upper mandible margined at the base with a narrow black band which broadens on the ridge and extends along the groove on each side to the nostrils; base of lower mandible fringed on each side with a membrane of a bright yellow colour, bordered behind with black, and forming a very distinguishing feature in this species.

Total length 2 feet 11 inches; extent of wings 7 feet 7 inches; from carpal flexure to the tip 22·5 inches; tail 9; bill, following the curvature of upper mandible, 5·3; length of lower mandible 5; tarsus 3·25; middle toe and claw 5·7.

The species was first described by Mr. Gould in the "Proceedings of the Zoological Society" (Part VIII., p. 177), and named by him the shy albatros, in allusion to its cautious habits when on the wing. In his "Birds of Australia" he gives the following account of it:—

"I first saw this species of albatros off the south coast of Tasmania, and had frequent opportunities of observing it during my stay in Recherche Bay, at the southern entrance of D'Entrecasteaux Channel, where I was wind-bound for nearly a fortnight. Unlike other albatroses it was most difficult to procure, for it seldom approached our ship sufficiently near for a successful shot. I succeeded, however, in shooting several examples while they were flying round the bay in which we had taken shelter. It is not usual for albatroses to approach the land or enter a secluded bay like that of Recherche, and I attribute this deviation from the ordinary habits to the temptation presented by the vast quantities of fat and other remains of whales floating about, the locality being one of the principal whaling-stations on the coast of Tasmania. I have no doubt likewise that it was breeding on the Mewstone and other isolated rocks in the neighbourhood, as the plumage of some of the specimens I procured indicated that they had lately been engaged in the task of incubation.

"It is a large and powerful bird, the male being scarcely a third less in size than the *D. exulans*; is rapid and vigorous on the wing, and takes immense sweeps over the surface of the ocean. It will be interesting to learn the extent of the range of this species. A head in the possession of Sir William Jardine was said to have been procured at the Cape of Good Hope, but I believe this was by no means certain. When fully adult the sexes differ but little in colour; the female may, however, at all times be distinguished by her diminutive size, and the young by the bill being clouded with dark grey. Besides being larger than the three succeeding species (namely, *D. culminata*, *D. chlororhyncha*, and *D. melanophrys*, to

which and the present the generic appellation of *Thalassarche* has been given), the beautiful grey on the sides of the mandibles and the yellow mark at the base of the lower mandible, will at all times distinguish this bird from the other members of the genus. The stomachs of those I obtained in Recherche Bay contained blubber, the remains of large fish, barnacles, and other crustaceans."

ART. XXVI.—*On the Addition of the Red-tailed Tropic Bird* (Phæton rubricauda) *to the Avifauna of New Zealand.* By WALTER L. BULLER, C.M.G., Sc.D., F.L.S.

[*Read before the Wellington Philosophical Soicety, 12th January,* 1878.]

IN the list of the Birds of New Zealand compiled by Mr. G. R. Gray and published in "The Ibis" of July 1862, the Red-tailed Tropic bird is included among the species of *Pelecanidæ*, the habitat assigned being Norfolk and Nepean Islands. On the publication of my Essay on the Ornithology of New Zealand (1865), in the absence of any positive evidence of its occurrence in our seas, I decided to omit this bird from our list of species, and it has been rigidly excluded since.

The fine specimen of the bird, however, which I have the pleasure of exhibiting to-night, and which was shot off the "Three Kings" by Mr. Henry Mair, and the further information which I have been able to collect respecting it will fairly establish the right of this species to a place in our avifauna.

The bird is well-known to the Ngapuhi tribe at the north, under the name of Amokura, and they set a high value on the long red tail-feathers which they exchange with the southern tribes for greenstone. Almost every year, after the prevalence of easterly gales, some specimens are washed ashore (generally dead) at the North Cape or in Spirits Bay. The natives of that district go out systematically to hunt for them at these periods. Owing to their rarity these plumes are more prized than those of the huia or kotuku, and in one instance a valuable slab of pounamu was given by a Hawke Bay chief in exchange for three feathers, one of which is now in the possession of the Manawatu natives.

The allusion is to this bird in the love-song of the fairies, commencing—

Kiatia taku rangi
Te kapu o te amokura, etc.

Come, deck my head
With amokura plumes.

Mr. Gould, who has figured the species with his usual skill in "The Birds of Australia," states that it "is very generally dispersed over the temperate and warmer latitudes of the Indian Ocean and the South Seas, where it often hovers round ships and occasionally alights on their rigging. During the months of August and September it retires to various islands for the purpose of breeding; among other places selected for the performance of this duty are Norfolk Island off the east coast of Australia, and Raine Islets in Torres Straits, from both of which localities I possess specimens of the bird and its eggs." He states further that the young birds for the first year are very different from the adults, being of a silky-white without the beautiful roseate blush (so conspicuous in the specimen now exhibited), with the whole of the upper surface broadly barred with black, and with the black of the shafts of the primaries expanded into a spatulate form at the tips of the feathers.

Mr. Macgillivray, who obtained several on Raine Islet in the month of June, gives the following account:—"Upon one occasion three were observed performing sweeping flights over and about the island, and soon afterwards one of them alighted. Keeping my eye upon the spot, I ran up and found a male bird in a hole under the low shelving margin of the island bordering the beach, and succeeded in capturing it after a short scuffle, during which it snapped at me with its beak, and uttered a loud, harsh, and oft-repeated croak. It makes no nest but deposits its two eggs on the bare floor of the hole, and both sexes assist in the task of incubation. It usually returns from sea about noon, soaring high in the air and wheeling round in circles before alighting. The eggs are blotched and speckled with brownish-red on a pale reddish-grey ground, and are two inches three-eighths long by one inch four-eighths-and-a-half broad. The contents of the stomach consisted of beaks of cuttle-fish. The only outward sexual difference that I could detect consists in the more decided roseate blush upon the plumage of the male, especially on the back; but this varies slightly in intensity in different individuals of the same sex, and fades considerably in a preserved skin."

Art. XXVII.—*Notice of a new Variety of Tuatara Lizard* (Sphenodon) *from East Cape Island.* By Walter L. Buller, C.M.G., Sc.D., F.L.S.

[Read before the Wellington Philosophical Society, 17th November, 1877.]

During a recent visit to Napier I saw in the possession of Mr. John White a live tuatara, which he had obtained from the natives more than a year ago as a chief's gift, and which one of his sons had succeeded in completely domesticating.

At the first glance at this lizard I observed that it was very different from ordinary examples, and on a closer examination it appeared to me, if not a distinct species, a sufficiently well-marked variety to deserve special notice in our "Transactions."

It is comparatively short and thick-set in form, and presents a remarkable depression in the occipital region. The dorsal spines (twenty in number) are very minute; those along the neck are larger, and number fourteen. The caudal spines are much thicker and dark coloured, all the former being pure white. The tail, which has been broken off at some period, is reproduced in the usual thickened form and in darker colours.

The measurements are:—

Total length along the dorsal line	14·5 inches
From chin to vent	8 „
„ vent to end of tail	6·25 „

The general colour is olivaceous-brown; sides of the body ruddy yellow with a flesh-coloured or pinkish hue, varied, spotted, and marked with olive-green and greyish-brown; on each side of the nape, large irregular ashy-white spots washed with yellow. The olive-green is brightest on the back and toes; and on the lower part of the former, on each side of the spine, there are irregular markings of ashy white. Throat bright ashy grey, with longitudinal series of minute white spots. On each side of the neck there is a broad crescent-shaped mark of olive-brown which encircles the pale-coloured throat. Under parts generally uniform pale grey; under surface of feet greenish-white. Colours darker on the (reproduced) tail. Claws horn-colour. Irides as in the ordinary form.

As will be seen from the above description, this remarkable example approaches more nearly, in the general character of its markings, to *Sphenodon güntheri* than to *S. punctatum*, although it is sufficiently distinct in appearance from both. It may turn out of course to be a merely accidental variety; but Mr. White states from recollection that another specimen obtained by the natives at the same time and from the same locality was exactly similar to this one.

This lizard has become perfectly tame, and appears to recognize its young keeper's voice. It greedily devours blue-bottle flies, caterpillars and insects of all sorts, and also feeds on fresh meat minced up. In the early part of December last it commenced to cast its skin, and it then became restless, making every endeavour to get underground. About the 1st January the old skin was completely thrown off, the colours of the new one being perceptibly brighter and more defined.

Mr. White states that this lizard was obtained on East Cape Island, and he has promised to furnish some further information respecting it after he has had an opportunity of comparing notes with the natives.

Art. XXVIII.—*Notes on the Physiology and Anatomy of the Tuatara* (Sphenodon güntheri). By A. K. Newman, M.B., M.R.C.P.

[*Read before the Wellington Philosophical Society, 22nd September, 1877.*]

Various early explorers either saw or heard of the tuatara, and many were their wonderful stories. A Mr. French eclipsed all others by describing a tuatara ten feet long, which he believed was quite harmless. Polack, whose work on New Zealand was published in the year 1838, speaks of it as a large and harmless reptile. Thomson, Shortland, Colenso, and others also made a few remarks on it. In the year 1842 Dr. Gray called it *Hatteria punctata*, and classed it as a distinct genus of the family *Agamidæ*. Three years later Professer Owen named it *Rhynchocephalus*, discovered that its vertebræ were amphicœlous, and that its skull was unlike that of other lizards. In the year 1867 Professor Günther published a very elaborate monograph on the tuatara in the "Transactions of the Royal Society." Dr. Knox criticized* this paper, and very briefly described certain characteristics which he had discovered from dissections made some years previously. Professors Huxley and Mivart have carefully described the peculiar position and form of the hyoid arches. Dr. Buller has written three articles on the natural history of this strange animal.†

Nomenclature.

The early travellers in New Zealand thought it was a member of the *Iguanidæ*. Dr. Gray called it *Hatteria punctata;* Owen changed it to *Rhynchocephalus;* Mivart and Huxley call it *Sphenodon;* Günther adopts the word *Hatteria*. The Maoris called it ruatara, tuatara, or tuatete. In the "Leaf from the Natural History of New Zealand," the Rev. Richard Taylor says:—"Ruatara, a lizard, eighteen inches long (guana), chiefly found on small islands. Tuatara, great fringed lizard (*Hatteria punctata*), now only found on the off-shore islets, the pigs having eaten them on the main-land. The word tuatara signifies 'having spines.' Tuatete guana synonymous with tuatara." Mr. Colenso says tuatara and tuatete are not synonymous; the tuatete was not eaten. It was also called kaweu in the Taranaki dialect.

Three species of *Sphenodon*, unlike in form and colour, have been discovered by Buller:—

(1.) *Sphenodon punctatum*, Gray, black, with myriads of light-coloured spots.

(2.) *Sphenodon*, Buller, not at all black, with much green and yellow.

(3.) *Sphenodon güntheri*, Buller, still lighter.

* "Trans. N.Z. Inst." II., 17.

† "Trans. N.Z. Inst.," III., 9; IX., 329; *ante* Art. XXVII.

The dark form is found in the North; the intermediate at East Cape Island; and the lightest form in the South.

Sphenodon punctatum was the form so elaborately described by Dr. Günther. The other species has not been anatomically examined.

Classification of Sphenodon.

At present the position of the *Sphenodon* in the *Sauropsida* is not yet quite certainly known. To meet the difficulty Dr. Günther proposes the following division of recent Reptilia:—

I. Squamata. II. Loucata. III. Cataphracta.

He divides the *Squamata* into *Ophidia*, *Lacertilia*, *Rhynchocephalia*. If external characters alone were considered, he says it would most resemble *Agamidæ*, of which genus Professor Peters thinks it merely an aberrant form. Professor Seeley talks of *Lacertia*, *Rhynchocephalia*, and *Crocodilia*. In his "Forms of Life," Rolleston talks of it as a "low lizard."

Huxley divides the *Lacertilia* into various groups:—I. Pterygoid and quadrate bones united. II. Pterygoid and quadrate bones disunited. Class I. he divides into A., a columella and inter-orbital septum; and subdivides it into those with amphicœlous and those with procœlous vertebræ—*Kionocrania amphicælous* and *Kionocrania procælor*. Those with amphicœlous vertebræ are again divided into *Acrodont* or *Pleurodont*, and *Thecodont*. There are three Orders: *Acrodont* or *Pleurodont Acalabota*, *Rhynchocephalia*, and *Homeosauria*.

Relationship with extinct Reptilia.

So far as is yet known the relationship between the *Sphenodon* and extinct reptiles is of great interest. Lyell writes:*—"The *Hyderapedon* was afterwards discovered in beds of about the same age (upper trias or keuper) in the neighbourhood of Warwick and also in South Devon, and remains of the same genus have been found in Central Italy and Southern Africa, in rocks believed to be of triassic age. It has been shown by Professor Huxley to be allied to the living *Sphenodon* of New Zealand. The recent discovery of a living saurian in New Zealand so closely allied to this supposed extinct division of the *Lacertilia* seems to afford an illustration of a principle pointed out by Mr. Darwin of the survival in insulated tracts, after many changes in physical geography, of orders of which the congeners have become extinct on continents where they have been exposed to the severer competition of a larger progressive fauna." Professor Huxley also discovered that the extinct lizards of the triassic age, viz., *Rhynchosaurus* and the *Hyderapedon*, were both closely allied to this *Sphenodon*. Still more recently, in Illinois, certain fossil reptilia have been found which possess a feature common alike to the *Archegosaurus*, stegocephalic batra-

* "Student's Elements of Geology," 349.

chians and the *Sphenodon*, viz., a longitudinal axial perforation of the vertebræ.

Professor Seeley, in a series of most elaborate essays, compares the bones of many living and extinct reptiles with each other. He finds that "The abdominal ribs of *Hatteria* are like those of *Plesiosaurus*, and in one species (for two species seem to me to be figured by Dr. Günther) the medium V-shaped bone is overlapped by a splice from a bone external to it. In another species this is replaced by a joint, and the external piece has a squamous expansion on the middle of its anterior and posterior margin, unlike anything seen in *Plesiosaurus*. But, as in *Plesiosaurus*, other bones are introduced between these elements, so as to make the abdominal ribs nearly twice as many as the costal ribs."* He compares *Ichthyosaurus* and *Sphenodon* thus:—"The apparatus of infracostal ribs seems capable of being moved away with equal entirety in both groups, owing to the union of some of the elements by overlap."† Günther thinks it most like the *Rhynchosaurus* of the new red sandstone of Shropshire.

Habitat.

Until the last few years tuataras abounded in certain parts of the South Island, especially on the banks of the Waimakariri river. About thirty years ago four were caught on Mount Victoria, near Wellington; one on Somes Island in Wellington harbour; and two by Mr. Mason, in the Hutt Valley; and in 1864 several were caught at Makara. They frequent the sandy banks of rivers, and hide beneath fallen trees. They abound on the Rurima Rocks, and on other islets in or near the Bay of Plenty, on Motiti, and East Cape Island. Many were found on the Brothers Rocks in Cook Strait during the recent erection of the lighthouse, but are now almost, if not quite, exterminated by curiosity-hunters. On the large islands none exist. Bush fires, wild pigs, dogs and cats, reptile-eating Maori tribes, and the advance of civilization have swept away all of these strange creatures, except the few which infest the tops of inaccessible rocky islets. Only one of the islets forming the Brothers group, in Cook Strait, was inhabited by them: this one was covered with loose sand and shingle, in which the tuatara burrowed holes. The other two uninhabited islets are merely bare hard rocks, affording neither food nor shelter.

Habits.

Tuataras grow very slowly; young specimens have apparently not increased in size during a whole year. A full-grown specimen must be many years old. One is known to have lived out two generations of men. Tuataras, like most reptiles, are very sluggish in their habits. They sleep during the greater part of the day, coming out of their holes at night for

* Jour. Linn. Soc., XII., 327. † *Loc. cit.*, 309.

food. They sleep much and very soundly, requiring to be much disturbed or pulled about ere they slowly waken. They are timid, much frightened by noises, and will run into their holes or to the nearest shelter or crouch motionless at sight of a man. They are very fond of water, liking to lie full length in it during great part of the day. One of mine laid several eggs in the water. They fight viciously, and bite hard. A skeleton in the Museum shows an old fracture of the mandible, with some displacement and callus, the result of a fight. Tuataras will live for months without eating, and then suddenly eat heartily every day.

Tuataras, like young crocodiles, will not eat flies or other insects that are still, or meat lying at the bottom of the cage; but if the flies or beetles run about or the meat is moved they will quickly seize it. Like young crocodiles too, they will not bite when caught. When eating, their jaws are moved straight up, no rotatory motion existing. Tuataras are perfectly silent. When caught between a man's fingers, their ribs being tightly squeezed, they utter sounds which are really groans, and even these sounds are uttered only when in great pain. When washed with soap and water the skin colours become very bright and distinct.

Tuataras lay their eggs in holes in the sand when wild, but when captive on the bare earth or in the water in their troughs. Like the common English lizards (*Lacerta viridis*) they lay eight or ten eggs at a time; they are about two-thirds of an inch in length, covered with a thick material containing a variable amount of lime. None of the eggs laid in captivity have yet been hatched. Mr. Burton told me that four tuataras laid eleven eggs in one night, but one of mine laid hers at intervals of several days.

Mr. Darwin, in his learned and fascinating work on "Sexual Selection," describes the arts and graces and appearances whereby male lizards woo their mates. The male tuataras have no special strongly-marked tints, no special personal attractions; and, unlike the males of several other species of lizards, are not much, if at all, bigger than the females. The absence of special sexual attributes is due perhaps to the fact that the tuatara, unlike other lizards, has no penis, therefore probably small sexual passions, and but little rivalry. The males are so like the females that they have not yet been distinguished with certainty. Dr. Günther, noticing the presence of a crest of dorsal spines and of long, slender, acute-pointed claws, thought that tuataras did not burrow. Tuataras not only infest the holes dug by the mutton-bird, but burrow others for themselves.

They burrow in the loose sand and pebbles on the banks of rivers or on islets. Captive tuataras are constantly burrowing; they dig the claws of their fore-paws into the soil, sometimes using the right and left paws alternately, at others using one for a long while; they fling the soil far

behind them, just as a dog does when scratching out a rat-hole. Günther objects to the belief that they burrowed, because he says their fore-limbs are slender; but the skeletons in the Colonial Museum show that they are not very slender, and are certainly strong enough and stout enough to be used for burrowing in loose soil. The long sharp claws too are admirably adapted for penetrating deep into loose sand or light loam. The claws are sharply carved out on their posterior aspects. They soon become blunted when used against the wooden or tin walls of a cage. The dorsal spines are no hindrance when entering holes, because they are very soft, being easily bent on themselves or pressed down on one or other side.

Locomotion.

Dr. Günther elaborately described the abdominal ribs, and, speculating on their use, inferred that their special function was "to assist in locomotion." He thought that by being approximated these ribs would assist the animal in crawling over rocks, especially as to each of the ribs (twenty-five or twenty-six in number) was attached a row of scales, the ends of which, he thought, were tilted up, thus causing a roughened abdominal surface, which would also help the animal. When dissecting a tuatara, it seemed to me that the amount of approximation between the ribs must be infinitesimal, and therefore these ribs could not be subservient to the special function of assisting in locomotion. I therefore carefully studied the motions of living tuataras, to ascertain which view was correct.

Tuataras are very lazy in all their movements, and even when frightened they move very slowly. Their usual pace is a very slow crawl, the abdomen and tail trailing on the ground. The femora are articulated at right-angles with the pelvis, and the tibiæ and fibiæ at right-angles to the femora; this mode of articulation causes a great strain on the muscles of the posterior limbs, therefore when at rest the trunk rests on the ground. I tried many experiments with mine and narrowly watched their movements. When driven fast, or when chasing prey, they *always lift the whole trunk off the ground*, it does not touch at any spot. This rapid gait is very "wobbling," something like a man swimming sideways. After running three or four yards they grow weary and stop. They cannot jump the smallest obstacle, their limbs being too feeble. In ordinary crawling they propel themselves by means of their limbs alone, and the abdominal ribs take no part in these movements, though trunk and tail rest on the ground. The abdominal ribs are not used during either slow or rapid movements, the limbs doing all the work; the limbs are quite strong enough to drag the body and tail along the ground, and during more rapid but very brief movements are powerful enough to lift the body and great part of the long heavy tail off the ground.

If a tuatara be lying with its abdomen across the edge of a plate

or the ridge of a stone it cannot wriggle itself off unless it uses its limbs. The trunk is short and these twenty-five or more ribs are very close together, the limbs not being far apart; they are bound together by large quantities of strong fibrous tissue, the amount of movement between each rib is very small, and when lifted off the ground and twisting its body about, the ventral plates do not have their roughened posterior edges tilted up by approximation of these ribs. I think that the abdominal ribs play no part in locomotion; whether the reptile crawls or runs or climbs up rocks the ribs are powerless, and afford the limbs no help. I am of opinion that the ribs are useful not to assist the limbs, but to act as a broad, strong, abdominal sole. Any one who has dissected a female tuatara with its eggs filling the whole abdomen, and has noticed the enormous size of these eggs, would be convinced that the abdominal ribs would be of the greatest use to the animal by supporting and protecting them from injury. A tuatara carries ten large eggs, all about the same size and weight, any two of these weigh as much as the whole of the other thoracic abdominal and pelvic viscera. These eggs lie in two parallel rows, extending from the cloaca, almost to the farther end of the thorax, they lie on these ribs, which support them, for the ligaments which attach the oviducts to the spine are thin and long. By this means the unusual weight is well distributed over the body. When crawling over the edges of sharp stones the ribs would protect the eggs and other viscera; with the true ribs and vertebræ they form a strong, compact and yet mobile case.

Günther also says the sharp claws "show that in a normal state they cannot be much used in dragging the heavy body or even in burrowing," but this is a statement founded on a misconception of their mode of progression. The tuatara walks on its pes and manus and not on its digits and claws. It is plantigrade not digitigrade, as indeed might easily be learnt from examination of the skin and its scales which cover those parts. When the animal is at rest the long nails keep the digits off the ground, and almost all the pressure of the limbs is on the pes and manus; the abdomen and tail rest on the ground wholly unsupported by the limbs.

Tail fracture and reproduction.

Of great interest is the subject of tail reproduction in tuataras. Professor Huxley says that "In many *Lacertilia (Lacertæ iguanæ geckos)* the caudal vertebræ have a very singular structure, the middle of each being traversed by a thin unossified transverse septum. The vertebra usually breaks with readiness through the plane of the septum, and when such lizards are seized by the tail that appendage is pretty certain to part at those weak points." Knox discovered that this curious feature obtained in the tuatara; he also learnt that the injured part will heal, but distinct

vertebræ will not be reproduced. Günther thinks that the tails of *Hatteria* are less easily broken than those of other lizards, because its external structures are less distinctly divided into segments or verticelli and strengthened by a thick layer of strong subcutaneous tissue:—"The epiphysial line passing through the middle and behind the transverse process, this line corresponds to the external vertical furrow between two verticelli." Knox, after carefully dissecting a specimen of *Naultinus greyi*, writes "that the separation not only occurred at a particular part of the spine, but presented an obstacle to its regeneration which appeared to me, and still appears, impossible. I found the divided or separated surface finely dove-tailed, the one (proximal extremity of the skin) presenting no dentations but a perfectly smooth margin, the scales surrounding the part arranged in symmetrical order, whilst on the separated part or tail eight wedge-shaped processes projected beyond the skin of the tail. These eight processes were entire and not caused by a tearing process, but were arranged in pairs:—

Dorsal margin	1 pair	Total, 8 pieces."
Abdominal "	1 "	
Lateral "	2 "	

"As," he continues, "I attentively observed the separation of the tail, I found that a delicate white cord was gradually leaving a canal in the tail portion. This I recognized to be the medulla spinalis, and necessarily rendered, in my belief, the power of reproduction still less possible."

In a young tuatara that I possessed similar conditions obtained; the processes were the caudal muscles, primordial, confluent at the base, and afterwards dividing into eight processes with tendinous endings. Contrary to what obtained in Knox's *Naultinus*, the processes were attached to the trunk and not to the tail portion. The processes were bare because the skin had retracted. Evidently the muscles had given way at the point of insertion into a vertebra. The muscles were arranged in a whorl. As in Knox's *Naultinus*, there certainly was no division through a vertebra. I apprehend that different forms of violence would give rise to different forms of fracture, and that though that through the epiphysial line might be by far the most common, yet it need not always occur. That the tails do occasionally fall off because of excessive muscular action is shown by the fact that lizards drop their tails when greatly frightened. On the other hand, if a lizard fall to the floor from table or roof, fracture through a vertebra would in all probability result.

Cuvier wrote that the tails of certain lizards are reproduced, but without spines or creases. This corresponds with what is found in the tuatara and *Naultinus*. The tails of the tuatara are divided into numerous joints, the skin between each joint being like that of the trunk, but the

joint itself is covered with much thinner skin and less tough tissue, and it is at a joint that the tail breaks. The tail bends only at the joints, the inter-spaces being rigid. The new tail is smooth, has no joints, is composed internally of cartilage, "like that of the lowest fishes," and by its external appearance can be at once distinguished from the older portion. In support of Knox's belief that owing to the dragging away of the medulla spinalis the tail would not be reproduced, I may cite the fact that experiments have shown that certain lizards which reproduce their tails will not do so if a red-hot wire be passed some distance up the vertebral canal thereby destroying the cord.

The tail may be fractured at almost any point; if at a distant point the animal soon recovers, but if near the pelvis it very frequently dies. In my full-grown tuatara the tail broke between the vertebræ; repair began by rounding of the broken end with compaction of cicatricial tissue. No scales were formed on the new part or new vertebræ in it.

Abdominal ribs.

In addition to a number of vertebral ribs, the tuatara has twenty-five or twenty-six (Günther) abdominal ribs (Knox's had twenty-five, mine twenty-five). They are double the number of the spinal ribs. To about the middle of each abdominal rib the spinal rib is attached, thus _/, forming a broad flat sole to support the viscera internally, and externally to protect it from injury. Günther considers "this system of bones is similar to but essentially different from that observed in crocodiles and some lizards (*Chameleon*, *Polychrus*, etc.), known as abdominal ribs or abdominal sternum, and considered to be the ossified inscriptiones tendinæ of the abdominal muscles." Günther also says, that "in no saurian, so far as we know at present, have they any relation to the external integuments." Knox thought they were dermal, and Rolleston calls them "parostotic ossifications of the subcutaneous fibrous mesh." This opinion must be incorrect, for they lie imbedded in the rectus abdominis muscle. An examination of skeletons will incontestably prove that they are not dermal or exoskeletal but endoskeletal.

Tuataras breathe slowly. As the abdomen and thorax are tightly bound in by abdominal ribs, the abdomen and thorax do not change their form, the vertebral ribs alone moving during respiration. If a tuatara be watched while breathing, it will be seen that the greatest amount of motion is at the junction of the vertebral and abdominal ribs. The lungs (merely thin bags) run nearly the whole length of the thoracic and abdominal cavities. The tuatara inspires, its throat swells largely, then the capacious lungs. The walls of the trunk are then motionless for many seconds, sometimes upwards of half-a-minute, ere expiration occurs. Owing to the peculiar shape of the

skull, with its two bars and additional bones, the pharyngeal cavity is enormously enlarged. When the tuatara inspires it greatly depresses the hyoid and trachea, thereby still more enlarging the pharyngeal cavity. By this means the tuatara inhales a large quantity of air, filling the lungs, mouth, trachea, and the large pharyngeal cavity. This peculiar mode of respiring by depressing the hyoid bone (which with its cornea is very large) enables the tuatara to inhale sufficient air to allow it to remain under water for hours without coming to the surface to breathe. The quantity of air in the lungs, trachea, mouth, and distended pharynx amounts to several cubic inches, which is sufficient to sustain life for some time in a small and cold-blooded reptile.

Tuataras swim freely—sometimes with only the nostrils above water, at others swimming as freely and well under it. As tuataras are found usually on isles, or on the banks of rivers, it may be that they find part of their food in the water. The *Ichthyosaurus* and *Plesiosaurus* marine reptilia had abdominal ribs, and the former amphicœlian vertebræ like the *Sphenodon.*

Dissection of Female Tuataras.

Total length, 16 inches, of which 8¾ inches were tail. Dorsal spines beginning at the occiput stretch along the back to the end of the tail; between the scapulæ five or six are wanting, and about three over the sacrum. Those on the neck and trunk are flattened laterally, blade-like, and acuminated; they are quite soft, and many are not erect. The caudal spines are attached one to each section of the verticellated tail. About the middle of the tail, instead of being flattened laterally they are prismoidal, being much wider at the base and not so sharp. As the tail sections dwindle so also do the spines till they can scarcely be said to exist. This tuatara has ten cervical spines, then an interval between the shoulders, then fifteen dorsal, an interval over the sacrum, and forty-one caudal spines. In *Lophocalotes interruptus* the spines, as in *Sphenodon*, reach from the head to end of tail, and are also interrupted between the scapula and over the sacrum. So also in *Tiaris tuberculata;* in this lizard there is on each side a row of secondary spines. In *Sphenodon*, as in certain other lizards where the spines are absent between the scapulæ, their place is occupied by a large black patch of skin; some spines are also black. The skin of *Sphenodon* is marked by several ridges which reach from head to tail, running parallel with the dorsal crest. One ridge extends along the trunk from the fore to the hind limbs; it is due to the free projecting ends of the abdominal ribs.

Two ridges beginning at the end of the rounded snout run backwards above the nasal openings and the eyes, giving a triangular look and a flat appearance to the form of the head. In many places the epithelial cells are accumulated, forming small spines which irregularly crown some of these skin ridges.

At the under surface of the jaw are small white scales, some partially others fully formed; they partially overlap each other, as do shingles on a house roof. At the throat they are more largely and fully developed, and are of irregular shape, usually with many straight sides and rounded edges. Gradually these scales become arranged in parallel rows, the posterior edge of the front row overlapping the anterior edges of back ridge. On the abdomen these plates are much larger and more regular in shape (parallelograms) and are arranged in rows, each row being closely bound by its anterior edge to an abdominal rib. About an inch from the transverse vent they become smaller, more irregular in shape, and the ends of the rows bend round, so that at the vent the rows are indistinct. Behind the vent they are small, but soon grow larger, and then rows of straight-sided plates almost encircle the tail. These tail plates are longer and narrower, though as regularly placed as those on the abdomen. Under the throat the skin hangs in loose irregular folds.

No sign of ears. Nostrils, two small holes almost hidden by lateral cranial skin ridges. These holes look upwards. A needle passed into them passes downwards and forwards—not backwards.

Mouth 1·2 inches long, quite straight.

Fore limbs shorter than the hind ones. Pes and manus have each five digits armed with sharp nails, curved like the teeth of a rodent. Pollux short and thick. Hallux slender and widely separated from other digits. Both pes and manus are large and covered on the under surface with small white scales.

To the exhaustive description of the abdominal ribs given by Günther I cannot add anything, except a remark on a peculiarity which he noticed in one specimen. He examined six specimens and in one he found "a very curious anomaly as regards the union of the three bones of which the abdominal ribs consist; *they were united by joints*." This peculiarity existed only in the alternate ribs. This did not obtain in either of my specimens, which belonged to a different species. It is therefore probably a variation, and not a mark of a distinct species.

Dentition.

Dr. Günther described specimens in all of which there were in each premaxillary bone a pair of incisors, far larger than any of the other teeth. These teeth were confluent at the base, and in old specimens when the cones were worn down, the incisor appeared as if a single tooth, resembling a rodent's incisor. Dr. Knox, however, found that in one of his two specimens there were in each premaxilla three teeth, all confluent at the base; the other specimen had but two cones. This newly discovered cone is nearer the middle line than the others. It is far smaller, slenderer, and sharper, and

would very soon be worn down. It looks like a mere rudiment. In one of my specimens (both from the Brothers) this third cone was present, in the other absent. The one in which it was absent was not, I think, an old specimen; its teeth are in good order and very little, if at all, worn. This therefore cannot be a specific distinction. Drs. Günther and Knox disagree in the number of teeth assigned to each maxilla and palate, but this arises from the fact that Dr. Knox considers several of them complex teeth, while Dr. Günther counts each cone as a distinct tooth. Günther says there are about eighteen teeth in each maxilla which Knox counts as six. I counted sixteen in mine and thirteen on each palate. Of the latter the largest and strongest were in the middle. The teeth of the maxilla press the food between the parallel rows of teeth, maxillary and palatine, and enter the groove between them. Thus the three sets of teeth are differently sharpened; the mandibular teeth have both inner and outer sides ground by the others, while the maxillary are sharpened on their inner and the palatine on their outer faces. The teeth in my specimens were thirteen in the palate, of which the anterior were very small. In the mandible nineteen, a canine and incisors, two in number, and confluent at the base. The teeth in mandible and maxilla near the incisors are very small, and are soon worn away or ground very small. In the other specimen was an additional incisor.

The muscles which move the lower jaw are very short, thick, and powerful. The crushing force of the jaws is very great.

The tongue is thick and rough, the glottis a long narrow slit, with closely-meeting raised edges. On forcibly opening the mouth of a living specimen the tonsils appear very large.

The posterior nares, two slits in the roof of the mouth, are situated just inside the maxillary teeth at the junction of maxillary and premaxillary bones.

Thorax, Abdomen, and Pelvis.

This large cavity is not divided by a diaphragm, though a portion of the peritoneum is attached to the ribs where a diaphragm might be expected. The peritoneum is a delicate membrane, in some parts colourless and transparent, in others darker. The peritoneum is almost black in and near the pelvis, but in many parts is much lighter, in some being of a greenish-brown tint. The peritoneum lines the whole of the trunk cavity, and gives off various large processes which attach the different organs to the spine; of these the largest are those which attach the rows of eggs to the spine. The processes attached to the oviducts are black, but the mysentery is transparent. The processes are half-an-inch in breadth, allowing the rows of eggs to rest on the abdominal walls. In the mysentery are long grey bodies, corpora adiposa.

The liver is a most curiously elaborated body. It consists of thin right and left lobes, and a part at right angles to these. The right lobe is thin with very irregular margins about one-and-a-half inches long. The left lobe stretches for half-an-inch to the left, at right angles to the central and spinal lobes. The left lobe is thin; its free portion terminates by shooting forwards a large portion. At the junction of the right and left lobes is an extremely irregular lobular body projecting backwards to the spine, and attached to the vertebral column by thin lateral ligaments. That portion of the liver which is nearest to the pelvis is attached to the pelvis by a long and strong ligament formed of peritoneum.

The liver is of a speckled yellow and slate colour. Günther says the bridge between the two portions of the liver crosses the lower surface of the posterior part of the stomach. His specimens were all males. In mine the eggs pushed backwards the stomach and the liver forwards, thus widely separating them. In my first specimen, in which the eggs were very large, the liver was much smaller than the other, and flattened against the abdominal ribs by the eggs.

Gall-bladder would hold a small pea; it contained a very small quantity of glairy fluid and some coagulated yellow material. Its walls are composed of thick white dense tissue; its duct is very short, and its walls thick. The branches of the portal vein are easily seen. The pharyngeal cavity is very large and very irregular in shape: its walls are thin. On the lower side it is closely attached to the trachea, by the depression of which the cavity is enlarged. The œsophagus is wide; its coats thicken near the opening into the stomach, and many rugose folds appear. Stomach small, with thick walls, passes almost insensibly into duoderum and small intestine, which are very short. The small intestine, with but two slight turns, runs straight down the abdomen to the cloaca. Longitudinal folds of the walls project into the cavity, beginning in the œsophagus, and continue through the stomach nearly down to the pelvis. The ileum and jejunum were filled with soft greenish material. The stomach is long and narrow, except where the longitudinal folds occur its surface is smooth.

Heart small, base very broad, apex very pointed. No sign externally of division into ventricles. The cavity is remarkably small, situated quite at the base and not extending near to the apex: there is but one cavity, there being no dividing material. The tissue of the ventricles is paler and smoother than that of the auricles, which is firmer, of a dark-red colour, and appears more cellular when divided. The ventricle is slightly overlapped at the base by the auricles. The right is larger than the left auricle. The heart is invested by a firm, closely-adhering pericardium.

The long straight trachea, whose rings only partially surround it, divides into two short bronchi, each of which ends in a large cavity. The lungs are two long thin sacs, with partly transparent walls. The walls have on their inner face a few villous-like projections. There is in each lung this one large cavity, therefore the bronchi do not divide or subdivide as in the higher animals. Each lung is one-and-three-quarter inches in length, each lies in close contact with the stomach. No thymus or thyroid.

Female Generative Organs.

In the first tuatara the whole of the abdomen and pelvis was filled with two parallel rows of eggs. There were five eggs in each row. All were about the same size, and appeared in the same stage of development. One was deep in the pelvis, and this seemed a trifle larger than the others. Its end too was sharper, and it was longer than the others: it was evidently being moulded ere being extruded, just as is the head of the human fœtus. These eggs were five-eighths of an inch in length, with their thin ends pointing towards the cloaca, and extended from the heart to the pelvis. They present a most curious appearance. All the other organs seemed squeezed and pushed aside by them. The space occupied by two eggs is equal to that occupied by the other abdominal viscera. The oviducts, firm white tubes, with constrictions dividing each egg from the others. Each oviduct is attached by a long, thin, black process of peritoneum to the spine; but this is long enough to allow the eggs to rest on the abdominal ribs.

In the space between these ligaments lies the spinal lobe of the liver. Each egg is covered with a thick dense membrane, composed of closely-interwoven bands of fibrous tissue, and lined by a thinner and smoother membrane. Each egg consisted of an oily-looking fluid, and lying in this a large dense yellow portion. In the eggs kept in spirits this portion was coagulated and granular. In the other specimen, where the eggs were far less developed, the dense internal portion alone was visible. The ovaries are two thin flattened bodies, attached by peritoneums to the ribs near the junction of abdomen and thorax. Each ovary contained great numbers of very small eggs, flattened by pressure against each other.

Bladder, large hollow viscus, extending half-an-inch above the pelvis, and opening into the cloaca. Günther says that the males have no "intromittent copulatory organ." Most *Lacertilians* have a double or bifid penis; the geckos have none. On account of the absence of a penis and a membrana tympani, Professor Peters proposes to class them with *Agamidæ*. Dr. Günther's description of the anal scent-gland in the males applies exactly to the females.

Muscles of hind limbs.

Musculus agitator caudæ, also called ileoperoneal, very long and thin, arises from the sacrum, passing behind the posterior border of the ilium runs down the outer and posterior aspect of the leg, and is inserted by a tendinous expansion into the outer and upper part of the fibula. In its course it covers in the great ischiatic nerve from its escape behind the ilium till it pierces the gastrocnemius and soleus. It draws the limb backwards.

Extensor quadriceps cruris should be called triceps not quadriceps, for it arises by three heads. The long head arises from the whole of the outer surface of the ilium, occupying the space which in men is occupied by the glutæi; it grows bulky and passes down the outside of the thigh to join the other heads. The short head arises from the whole of the outside of the femur just below the insertion of the M. pectineus. The third head arises from the ilio-pubic suture, and near the knee joins the other heads, from which it is at first widely separated. The musculus pectineus divides the last two heads. The slender head arises close to the origins of the gracilis and sartorius. The three heads converge to be inserted by a very broad and strong fascia and ligament into the upper surface of the tibia. The ilio-pubic head draws the limb forward.

There is a muscle which Günther calls pectineus, but which Mivart and Sanders, in *Menopoma*, call psoas and iliacus. I think it should be called iliacus. Günther calls a wholly different muscle iliacus internus. I know not why, for it is an external muscle, corresponding in size to glutæus medius. A muscle arises from the inner surface of the cartilaginous edge of the uncinate process of the pubis, and passes on over the edge of the ilium, to be inserted into the fascia lata, in the same manner as the tensor vaginæ femoris. Below this small muscle is the one which Günther calls pectineus; it is large and springs from the whole of the ventral surface of the pubis and ilium, crosses the ilio-pubic crest, lies close to the acetabulum, and is inserted by a broad tendon into the middle-third of the outer surface of the femur. It also arises from the ilio-pubic ridge. It draws the leg forward and rotates it outwards: it is very powerful. This muscle and the preceding one are separated from the bladder and cloaca by peritoneum. In some lizards this muscle arises by four heads. In *Platydactylus japonicus* Sanders found the muscle which I have called tensor vaginæ femoris.

Musculus gracilis arises from the uncinate process of the pubis, anterior to origin of the long head of extensor cruris, runs down the inside of thigh alongside the head of the biceps, and is inserted into posterior and upper part of the tibia. It antagonizes the biceps.

A broad thick sheet of muscle arises from the symphysis ossium pubis et

ischii, and uncinate process and anterior border of the pubis. It is closely connected with the gracilis. In *Iguana* Mivart calls this broad sheet sartorius; Sanders, in *Platydactylus*, calls the broad sheet sartorius, and the slender gracilis. The fibres of this broad mass converge and pass down the inner side of the thigh to be inserted into the posterior part of the tibia just below the head. Günther calls this sheet a prolongation of the M. obliquus abdominis externus.

A strong broad ligament reaches from the uncinate pubic process to the symphysis ossium ischii. From the under-surface of this ligament, about its middle-third, arises a narrow muscle which is inserted into the middle of posterior surface of the femur. It adducts the leg. It is probably biceps femoris; but the distinctions of some of these muscles are difficult to make out. The semi-tendinosus and semi-membranosus (?) arise from the tuber ischii, and by a branch from two or more caudal vertebræ, and are inserted into the tibia. These muscles flex the limb, or if that be fixed assist in moving the tail.

M. obturator externus arises broadly from whole outer face of pubis and ischium, lies in contact with the pubis and ischium, closely covers in much of the hip-joint, and is inserted by a flattened tendon into inner tuberosity of the femur and digital fossa.

Obturator internus arises from ramus and body of pubis, from symphysis pubis, and from uncinate process of pubis, from outer surface of tuber ischii and ramus ischii, and from membrane lining obturator foramen. Ischio-caudal arises by a narrow tendon from the tuber ischii, and is attached to the hæmapophyses of six or seven caudal vertebræ. Internally, it lies against its fellow of the other side, the arms lying between them near their origins. Externally, both are covered by the femoro-caudal, which arises from the sides of the hæmapophyses of several vertebræ; the thickest fibres arise from the vertebræ nearest the sacrum; these form a round thick mass. The insertion is very curious. The broad thin layer of fibres coming from the more distant vertebræ unite to form a strong glistening tendon which passes under the ischio-caudal ligament to the inside of the upper end of the femur. About one-third of an inch from this insertion it gives off a very delicate long branch, which runs down the whole length of the femur in close proximity to the great ischiatic nerve, which it very closely resembles; it traverses the popliteal space, and is inserted into the back of the fibula. The long slender tendon helps to flex the leg upon the thigh, and acts also on the popliteal fascia. The other tendon would draw the leg backward or move the tail. Günther thinks it would also rotate the limb outwards; but this perhaps is not the case, because the tendon at insertion so grasps the leg as (possibly) to neutralize any such effort.

M. iliacus (a muscle so called by Günther) arises from the whole of the ascending outer surface of the ilium, directly covers in the hip-joint, and is inserted by a broad fleshy band into the posterior and hinder aspect of the femur. Its origin is hidden by the long head of the extensor cruris, and is separated by the very strong fascia. This muscle resembles in position, origin, and insertion the glutæus in man.

Quadratus femoris arises from the border and side of the tuber ischii, and is inserted into the digital fossa. It is a small muscle, about one quarter the size of the obturator externus. Gemelli and pyriformis are represented by a small mass of muscle coming from the ventral surface and posterior edge of the vertical ilium, and inserted into the head of the femur just below the capsular ligament.

Acetabulum.

Length of cavity half as long again as the breadth; lower border straight, upper curved. Capsular ligament very strong, lined by synovial membrane. It embraces the edges of the acetabulum, and is especially thickened on the *upper* part by a ligament corresponding to the ligamentum teres in man. This ligament is inseparable from the capsule; the latter is also specially thick anteriorly. The acetabulum faces directly outwards and slightly backwards. Acetabulum shallow, very slight lip, dislocation would easily occur but for the cartilage round the edge, the capsular ligament, and the muscles which lie in contact with and materially strengthen it. The obturator foramen is long and oval, filled by a membrane, which is pierced by the obturator nerves and vessels.

Fascia.

Fascia lata of the thigh is attached to the pelvic rim and superior external border of the ischium; here it is strong and thick and covers the whole of the outer side of the thigh and ends in a broad aponeurosis which closely envelopes the knee joint. It receives the insertion of the tensor vaginæ femoris. The fascia is very intimately connected with the long head of the extensor cruris, much resembling relationship between the human glutæus maximus and fascia lata. A very strong fascia closely binds the caudal muscles.

The great ischiatic nerve passes out behind the ilium, gives off numerous branches and runs down the popliteal space, in the lower part of which it divides into several branches just prior to entering the sural muscles. It is covered in by the musculus agitator caudæ, to which it supplies a branch.

Muscles of fore limbs.

The deltoid arises from the posterior portion and border of the cartilaginous scapula and passes directly downwards to be inserted into the middle of outer side of humerus, its tendinous portion passing between the triceps

and coraco-brachialis. The supra-spinatus, teres and infra-spinatus form a broad mass arising from the scapula, and, still continuing a broad mass, pass over the shoulder joint to the outer and upper part of the humerus.

The serratus magnus arises from the fourth and fifth ribs, and from the hæmapophyses passes forward to the posterior border of the cartilaginous and bony part of the scapula. The more numerous and powerful fibres are inserted into the bony portion. The subscapularis large thick muscle takes its origin from the inner surface of the bony and cartilaginous scapula and is inserted into the humerus. No rhomboidei (Günther). The biceps brachii arises by one head from the scapula and humerus, by the other from the surface and margin of the cartilaginous coracoid; opposite the shoulder it narrows into a thin tendon, and over this the tendon of the pectoralis-major plays freely; becoming fleshy again it travels down the arm, its tendon of insertion piercing the flexor and extensor muscles of the fore-arm and reaching the ulna. The coraco-brachialis arises from the coracoid, and is inserted down the whole length of the humerus as far as the external condyle. A large flat muscle arises from the coracoid bone near its junction with the scapulæ and is inserted into the head of the humerus—epicoraco-humeral. In *Iguana* Mivart describes a similar muscle. The triceps arises by only two heads, one attached to the constricted part of the scapula, the other a long fleshy slip coracoid. They join, and forming one muscle are attached all down the posterior surface of the humerus and into the olecranon.

Throat muscles.

A broad strong sheet of fascia arising from the clavicle passes forward, covering in the under surface of the neck and becoming attached along the whole length of the inner surfaces of the mandibles, becoming much thinner near their junction, and is connected by loose cellular tissue with the deeper muscles. The mylo-hyoid is well developed; it stretches from mandible to mandible. The sterno-cleido-mastoid arises fleshy from the whole of the clavicle, passes forwards and upwards to be inserted into the mastoid and parietals. It may easily be divided into several portions looking like distinct muscles. By two heads the omo-hyoid arises, one from the outer end of clavicle, the other from the inner. In *Iguana* this muscle arises by one broad head. It wends inwards to the mesial line and passes upwards to be inserted into the laryngeal cartilage. It is separated by cellular tissue from its fellow-muscle, and internally is closely connected with the trachea. It is probably what in man is distinguished as sterno-thyroid and omo-hyoid. The genio-hyoid is a small muscle inserted with its fellow into the mandibles near their junction. The stylo-hyoid arises from the mastoid and ends in a remarkably long tendon, which curves round the posterior

border of the jaw, lying in a groove in the cerato-mandibular, is closely held to the long hyoid horn, and is inserted beneath the omo- and sterno-hyoid. The digastricus arises from the posterior border of the mastoid, slopes downwards and backwards to be inserted into the posterior angle of the mandible. It hides the insertion of the sterno-cleido-mastoid and other cervical muscles. It is a very strong muscle opening the mouth.

The skeleton has been so ably and so exhaustively described by Dr. Günther, that any further description would be mere repetition. In a short paper at a future date, I hope to describe the arteries, nerves and brain. The hyoid bone with its cornua, attachments, and the light it throws on the origin of the human auditory ossicles has been fully described by Mivart and Huxley.

Art. XXIX.—*Disappearance of the Small Birds of New Zealand.*

By D. C. Wilson.

[*Read before the Auckland Institute, 22nd October*, 1877.]

Amongst the many changes which pass almost unnoticed by the majority, one much to be deplored goes on around us daily, which promises to deprive our forests of one of their chief attractions. I allude to the destruction of its smaller feathered inhabitants, amongst which unfortunately are numbered our singing birds.

In detailing the cause of this destruction it may be well to give a short description of the birds which are disappearing, together with some idea of their habits, as also those of their destroyer, the rat. This animal sails in ships all over the world, an unwelcome passenger, and makes its way ashore on every land. Its first proceeding is to kill and eat the aboriginal rat of the country, which it then takes possession of and colonizes.

The country from which this rat first sprung is supposed to be India or Persia. We are accustomed to call it the Norway rat, probably from the accidental circumstance of its coming first from that country to England; but the Germans call it the "wandering rat," and it is said to have made its appearance in different European countries almost at the same time.

The native species was a small black animal, and much prized by the natives as an article of diet. Their method of capture was to construct a pit wider at the bottom than the top; then strew some roasted hinau berries over the floor, and place a log to serve the rats as a ladder. After a night or two, when the rats had got accustomed to being fed in this manner, the log was removed. The rats, unable to resist the savoury smell of their

favourite food, jumped boldly down. On seeking to return they were prevented by the overhanging sides of the pit, and in the morning the Maori hunter found them safely trapped. These pits may still be seen on remote ranges; they formed a fruitful subject for dispute; and a common claim made by a native in the present Land Courts is, that his ancestors hunted rats over the part under discussion.

But the Maori species seems to have been a vegetarian, and with him we have no more to do. Our rat on the other hand appears to have but little choice in the article of diet, eating indiscriminately berries and fruit, fish, flesh, offal, and carrion; eggs they have a special predilection for, and some amusing stories are related of their clever theft and adroit removal of these delicacies, under circumstances of unusual difficulty.

They are expert climbers, and any old bushman must have witnessed the celerity with which they run along a small twig or supplejack; in fact, they appear quite as much at home amongst the tree-tops as in the sewers of London or Paris. In the bush their numbers are prodigious; and if a party remain at a camp long, they become very bold and troublesome, causing sometimes thoughts of being eaten alive by them, which fate is said to have actually overtaken men in the sewers of Paris. With those tastes, then, coupled with their enterprising disposition and ferocious habits, it can be readily imagined how, after the slaughter of their Maori brethren, they should direct their attention to robbing birds' nests and eating the young.

After thus noticing the rats we now come to the birds, which have suffered most from their ravages; and it is a significant circumstance that, while some birds below a certain size have almost entirely disappeared, the larger ones seem to remain as plentiful as ever; and those of middle size, such as the kokako and tui, although diminished in number, still continue to enliven the forests with their song. This fact points to a defence of their nests, made by the larger birds with success, but doubtful in the case of the middle-sized ones, and depending on the boldness of the rat; while it would be almost hopeless in the case of the smaller ones.

Amongst the birds which are becoming scarce, the first we shall notice is the kokako, a brown bird somewhat larger than a tui, with a bluish tinge about the head and throat; it has a long-drawn note, somewhat nasal, but very melodious withal, and which harmonized well with a full chorus of birds; but this is now seldom heard.

The appearance of the tui must be so familiar to all as to need no further notice than a simple mention of the fact, that their numbers are sadly thinned within the last twenty years.

Amongst the birds which have altogether disappeared, we must include the bell-bird (korimako) and robin (pitoitoi). The former seemed to be

the first victims, and their disappearance dates some fifteen years back, since which time it has been a rare sight indeed to see one; this loss is much to be regretted, as the bell-bird was by far the best songster of the New Zealand forests.

The robin was a small brown bird of peculiarly gentle aspect and tame disposition, resembling in fact his English namesake in everything except colour. The disappearance of these birds began nearly about the same time as the bell-bird, and now the rising generation will scarcely ever have seen a single individual of the species.

It is somewhat singular, however, that while these and other birds have become extinct in this part of the island, some of the smaller kinds have suffered apparently but very little diminution; and with a reference to these we will conclude the chapter.

Most notable amongst the survivors are the fan-tail or fly-catcher, and the riroriro. No other bird forces itself so much on the attention of the dweller in the bush as the fan-tail. They haunt about a camp and find an easy subsistence on the flies which there congregate, darting about with outspread tail in pursuit of their prey, and giving vent to their feelings in a sharp, petulant note.

On resuming the occupation of an old whare at times, some of these little creatures will pay an early visit to those whom they evidently look upon as old friends and benefactors, and on such occasions they will plainly testify their satisfaction at a renewal of the intimacy.

The riroriro, which corresponds to the old country wren, is a small grey bird of unpretending appearance, but, like many unassuming individuals of our own species, they belie their looks, possessing a more than usual share of sagacity and instinct. Their nest is shaped like a pear, with a door in the side sheltered by a small veranda-like projection, and the natives aver that this nest is built so that the door is always turned in the direction opposite to the prevailing wind of that year. Finding a nest then in the spring, with the hole faced to the north, a season of southerly winds and consequent fine weather may be predicted, and *vice versâ*.

It is said that the severity of a winter in North America may be predicted by the quantity of nuts found in the hoard of a squirrel, and similar instances of prophetic sagacity might be multiplied; in fact, instinct taken by itself is utterly beyond our comprehension, and cannot be accounted for by any effort of human reason. There is no doubt, however, that the bird is weather-wise beyond the common, and a well-known Maori song alludes to it thus:—"The riroriro sings, it is a sign of the approaching summer." This peculiarity I can vouch for myself; on many occasions my attention was drawn by the continued singing of these birds, and it was

always followed either by spring or else a long continuance of fine weather.

It is possible that the fact of these birds' nests being hung to sprays so slender that they will not bear the weight of even a rat, may account for their survival, but certain it is they have suffered very little. Whether the spread of cats will affect the birds or rats most remains to be seen; but judging from the change produced in this neighbourhood, it would appear that the rats suffer severely from their natural enemies, and whereas they swarm in thousands throughout some parts of the bush, in other localities food may be left for weeks and remain untouched. This phenomenon has only been noticeable of late years, and points to the establishment of cats at different parts of the forest.

Before concluding this paper I would briefly notice the action of the Acclimatization Society in introducing useful birds, and it seems hard that a body of men who spend so much time in trying to benefit their country, should be held up to the execration of their fellow-colonists. The circumstances in which country settlers are placed must be allowed, however, to be very peculiar, and the irascible tone of the sufferers whose letters may be seen weekly is caused by the following facts,—the sparrows and yellow-hammers which are now devastating the young grain crops, etc, have not yet become accustomed to the country, nor has the habit of feeding on grain which they learnt on the passage out left them; it may even be handed down from the parent birds to their young.

Again, grain-producing farmers here are few, scarcely more than one out of six, and these unlucky wights perhaps live in isolated spots, surrounded by large wastes or forests, where their feathered enemies breed unmolested, the birds are not evenly spread over the country, but moving about in waves, and always most numerous on their front. A single farmer may thus have to feed a number of birds which in the old country would have been distributed amongst a hundred, and their ravages scarcely felt. I am, however, confident that like thistles, blight, and many another scare, this of the birds will pass away also, and much good result from their introduction; caterpillars and other insects have caused more loss than can ever be inflicted by birds, so let us hope that settlers will look past the little inconveniences of the present.

ART. XXX.—*On two new Fishes.* By F. E. CLARKE.

Plate. VI.

[*Read before the Westland Institute, 12th December*, 1877.]

BEFORE proceeding with the descriptions of the new species of fishes I have the honour to bring under your notice this evening, a few remarks may not be out of place.

Situated as we are on such a comparatively barren and exposed coastline, many perhaps will be astonished to hear that the opportunities for collecting the rarities of pelagic life are much more frequent than might be expected. Our exposed position at once accounts for this; as a gale or strong wind from almost any of the western points of the compass sends home a heavy sea to our beaches, and, in all such cases, although a "heavy blow" to some of the beach residents, affords delight to the collector; thus again proving the old adage, "'Tis an ill wind that blows nobody any good."

The fish I purpose first describing belongs to a genus exceedingly rare, and up to the present has been found (after violent storms) in a few isolated situations in the Mediterranean and Atlantic only. The number of species (inclusive of our own) is five, and the individuals met with might almost be numbered on our fingers. More common genera of the family to which they belong, such as *Scopelus*, *Maurolicus*, and *Gonostoma*, and with them *Cyttus abbreviatus*, Hector,*—a fish the typical specimen of which was dredged up during the "Challenger" expedition off the coast of New Zealand from the great depth of 400 fathoms—are cast up on our coast more or less by every gale which sends a south-west sea home. And here let me digress, and perhaps infringe on one of Captain Turnbull's specialities, "the currents." The continuous set of current from south-west up the coast has not been as prevalent lately as four or five years back. Then the occurrence of the purely pelagic fishes—Crustaceans and *Hydrozoa*—was much more frequent. Of late years the direction of wind has averaged more north round by east, than south round by west, thus retarding the "set," and driving any waifs and strays on surface currents from the coast. Only at intervals has the "set" regained its former constancy with strong southwesters, and we have again our casual flotsam.

The fish secondly described forms a new genus in the family of Pediculati and is truly "a king among kings" in a class of fishes containing some of the most grotesque forms in nature. The probable use of the tentacular appendage as an attractive lure, is beyond conjecture, as the habits of an

* "Trans. N.Z. Inst.," VII., p. 247, and IX, p. 465.

allied fish (the angler), which is supplied with a far less complicated attachment, have been closely studied and proved it to be "a fish which angles for fish," with a natural rod, line, and bait, and with certainly as deadly a "creel" as any human disciple of Isaac Walton might have to which to relegate its captives.

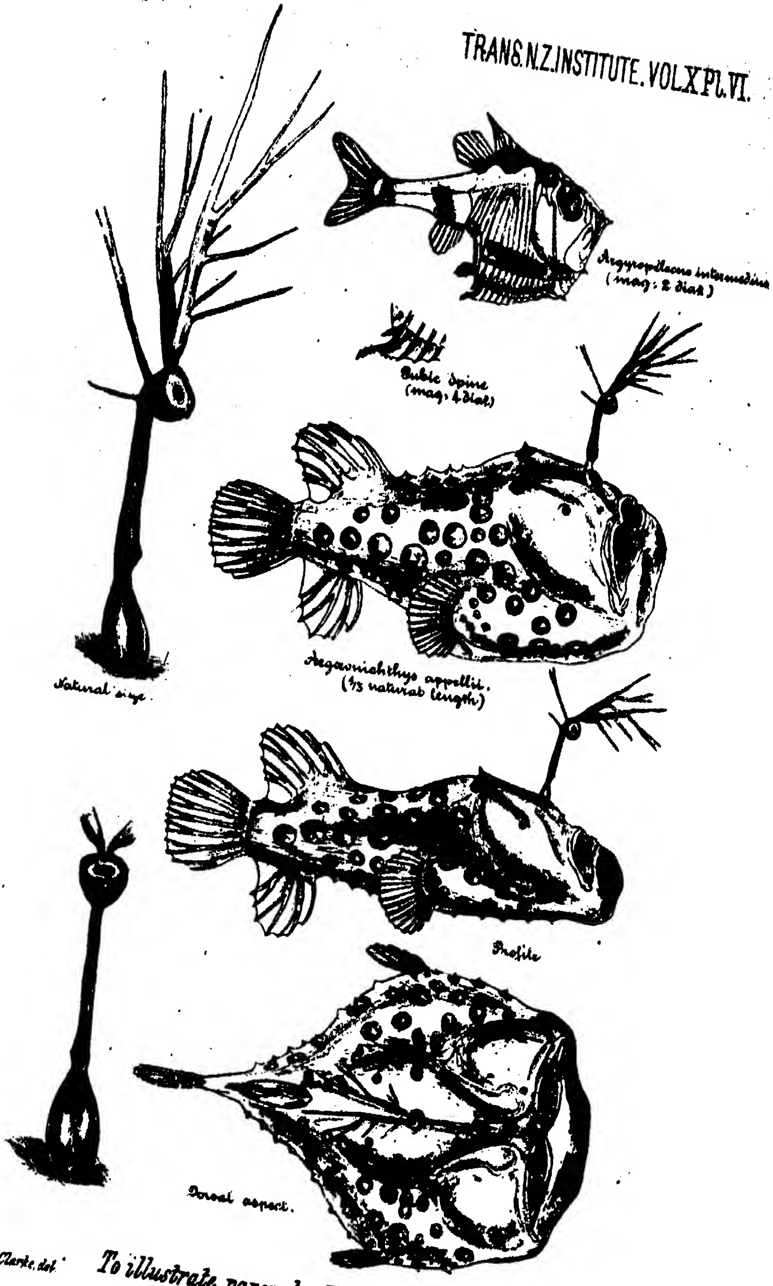
I take this opportunity, too, of acknowledging with thanks the kindness of Mr. Appel, V.S., of this town, to whom this last fish was sent by its collector, and who has kindly allowed me to figure and describe it.

ARGYROPELECUS INTERMEDIUS, sp. nov.

D. 1–7; P. 7; V. 6, single; A. 7; C. 24.

The height of the body equals length, and is less than the distance between gill-covers and root of caudal; the length of head is contained three times in distance from end of chin to root of caudal; tail very slender; abrupt termination of body midway between tip of snout and end of caudal fin (expanded); osseous dorsal plate with one double and four (last very minute) spinous processes imbedded in its substance; pectoral fin barely reaches to ventral; orbit of eye oblong, pupil on summit; eyes approach very close together on top of head; posterior margin of præoperculum almost borders hind part of orbit, descends in straight line and terminates in a double spine, the superior curving upwards, inferior continuing in direction followed by margin; prominent spine at posterior corner of mandibles; spine on chin, pointing directly forwards; spine over temporals; spine on throat, before commencement of serrature; serrature terminates in double pubic spine, the inferior portion of which is curved and barbed, presenting a very formidable armature though on so small a scale; no appearance of adipose fin; commencement of soft dorsal fin midway between snout and end of tail; pectoral and caudal fins well developed; one ventral fin only, placed in median line of body above pubic spine; four luminous spots on lower side of tail before commencement of caudal fin; six over and partly behind anal fin, and three immediately in front of same, all surrounded with black skin; long luminous streak on lower abrupt termination of body above pubic spine; along lower sides of body a superior row of spots, ten in number, to base of pectoral fin, and an inferior series, thirteen in number, terminating in vertical with posterior limb of præoperculum, each spot in the above two rows being in intervals between ribs, which are very prominent, giving a striate appearance to body; under margin of gill-covers, and on throat before pectorals, a series of four spots; single series of recurved conical teeth, minute at angles of gape on upper jaw, large towards centre of upper and lower jaws; tongue thick and fleshy; sides of body, cheeks and throat covered with silvery pigment; back, top of head, and tail bare; back dark-purplish brown; tail flesh-coloured with dark

TRANS. N.Z. INSTITUTE. VOL. X. Pl. VI.



F.E. Clarke, del. To illustrate paper by F.E. Clarke.

mottled band above, and a series of luminous spots before caudal and over anal fins; eyes, iris dark blue, pupil black; fins almost immaculate.

	Inches.
Total length	1·22
Total depth	0·60
Length of body	0·60
Longest diameter of eye	0·14
Shortest do. do.	0·10
Length of head	0·34
Distance from posterior margin of gill-covers to end of tail..	0·70

Specimen was collected on beach, Hokitika, 28th October, 1877, after heavy gales; other fishes obtained at same time belonged to genera *Cyttus*, *Maurolicus*, *Gonostomus* and *Scopelus*, and a pelagic crustacean, *Phronima novæ-zealandiæ*."

Family, *Pediculati.*

Nov. genus, ÆGŒONICHTHYS.

Head and body excessively large, broad, and depressed; tail very short; mouth exceedingly wide and vertical; supra-orbital bones produced into heavy ridges, divergent posteriorly, covered with the common skin and terminating in a small strong spine directed upwards; between ridges a deep groove in which is situated over head a compound appendage capable of movement in an almost universal manner and with a thick, pear-shaped, muscular base, bony shaft, surmounted with a semispherical capsular gland, from the back and upper margin of which arise one simple, one double-branched and two compound-branched fleshy tentacles, terminating at free ends of branches in white shining vermiform tips; the front of the capsular gland is covered with a silvery or nacreous integument with aperture in centre connected with interior and surrounded with a black ring; body and tail armed with broad-based conical spines ending in fine points; one short dorsal and short anal each terminating close to caudal and placed far back; pectorals small and but imperfectly pediculated; teeth in both jaws very numerous, in various rows, and of unequal lengths, they are slightly recurved, flat, sharp-pointed with cutting edges, moving freely in socket when pressed in direction of interior of mouth but perfectly rigid in opposite direction; the teeth in pharynx short and recurved, and in clusters on branchiostegals; gill openings in axillæ and partly on under surface of body.

Habitat—Seas of New Zealand.

ÆGŒONICHTHYS APPELII, sp. nov.

D. 5; P. 17; A. 4; C. 8.

Spines more numerous on ventral surface than on sides or back; inside the mouth at the back of the teeth (upper and lower jaws) is a black tough fleshy flap extending from one side to the other; tongue immensely broad,

thick, and fleshy; cavity of mouth enormous; the intestine must be very short and digestion capable of being carried on within the mouth itself, as on opening same the cavity seems almost to extend to anus; skin slimy and soft; fins and fin-rays thick and fleshy; eyes very small, covered with the common skin; nostrils small tubular; cheeks solid.

	Inches.
Total length	12·5
Greatest breadth (immediately before pectorals)	6·7
Width of mouth	4·5
Diameter of eye	0·27
Height of dorsal	2·0
Length „	2·3
Height of anal	1·5
Length „	1·5
„ of pectoral	1·2
„ caudal	2·2

Bony shaft of compound appendage and outside of capsular gland covered with minute striate-based spines; chin solid, square, and projecting.

	Inches.
Height of shaft of appendage	2·0
Diameter of capsular gland	0·4
Length of longest tentacle	3·0

Ground colour greyish, mottled with light and splashed with dark brown; appendage brown, mottled with darker, tentacles dark brown with white tips. Eye, iris grey, pupil black. Fins greyish.

Art. XXXI.—*Notes on* Regalecus pacificus, *a new Species of Ribbon Fish from the New Zealand Seas.* By Julius von Haast, Ph.D., F.R.S.

Plate VII.

[*Read before the Philosophical Institute of Canterbury, 15th December,* 1876.]

Mrs. George Oram, of New Brighton, kindly informed me on the evening of May the 7th of this year (1876), that in the morning of that day a gigantic frost-fish had been found on the beach near the hotel, to which it had been brought, and that she would be very glad if I would come and inspect it. The next morning I proceeded there, and found the specimen in question, with a few minor exceptions, in a splendid state of preservation; and as that lady has kindly presented it to the Museum, I am not only able to offer a description of this remarkable fish, but my friend Dr. L. Powell, F.L.S., has also prepared a careful drawing, and offers in an appendix a few remarks on its anatomy and on the results of a microscopical examination of its so-called scales.

On measurement I found this beautiful fish to be 12 feet 5 inches long, having an average breadth of 13·5 inches and a thickness of 3·5 inches. The whole skin is covered with a coating looking as if it consisted of frosted silver, and which adheres to the fingers very easily. The brilliancy of this silvery appearance is still more prominently brought out by numerous tubercles which stand above the skin, and by a number of irregular black lines and spots in the anterior portion of the body.

If we add to this the fine metallic iridescence of the head, which possesses at the same time a crest of bright red spines on the top, it is not too much to say that the form and colouring of this species make it the most beautiful fish ever obtained on the coasts of New Zealand.

The capture of these greatly compressed, sword-like, deep-sea fishes occurring at such long intervals, and of which so little is known, has always excited the curiosity of the public and the deep interest of the naturalist; and cases when specimens of this genus were secured in England and on the continent of Europe were generally noted in the publications of the day.

On examining the literature dealing with this genus, I find that this specimen is new to science, and I therefore propose to describe it here under the specific name of *Regalecus pacificus.* It is very different from the *Regalecus* described by Mr. W. T. L. Travers, which towards the middle of October, 1860, was stranded on the beach near the entrance of Nelson harbour, as "from the lower lip of that specimen depended a large number of rigid slender barbules about sixteen inches long and of a brilliant red colour."*

The description given in that standard work proves that very little is known of these occasional visitors from the deep seas, as there are six species enumerated, of which most have been described from single and generally mutilated specimens only.

REGALECUS PACIFICUS, Haast.

B. 6 D. $\frac{9}{223}$ P. 12

The length of the head is 7·75 inches, and height behind the eye 6·75 inches, consequently the length of the head is one-nineteenth of the total. The height of the body is—

2 feet from snout	13·25 inches
3 „ 9 inches from snout	13·75 „
4 „ 11 „ „ „ at anus	13·25 „

after which it tapers gradually to the tail.

3 feet from tail	9·50 „
1 „ „ „	6·25 „

* Günther's Catalogue of Acanthopterygian Fishes, Brit. Mus., III., 307.

Consequently the greatest height of the body to the length is nearly one eleventh. The greatest thickness of the body along the line of the vertebræ, 3 feet 6 inches from the snout, is 3·5 inches, gradually it increases to 4 inches at 4 feet 2 inches from the snout, a thickness it sustains for 4 feet more, after which it gradually diminishes till 3 feet 6 inches from the tail it has dwindled to 2·25 inches. The ventral edge of the body is broader than the dorsal one. Colour generally silvery, with a tinge of lavender. When the fine silvery coating is still attached, the tuberculated bands look lighter than those on which the tubercles are very minute. On the other hand, when this coating is rubbed off alike, the smooth bands look the lightest. In the latter case the tuberculated bands appear steel-coloured, on which the tubercles stand prominently with a silvery white lustre. On both sides are a number of blackish irregular stripes and blots, mostly elongate in the anterior portion, gradually decreasing and ceasing near the anus. The whole skin is also covered with dark rings, mostly of a round form, inclosing a lighter space. They are generally 1·5 inch in diameter and stand about one inch from each other.

Snout truncated with a very protractile upper jaw and a vertical cleft of the mouth. No teeth. The eye, which has a somewhat oval form, the largest diameter being in the horizontal direction, is 1·25 inch broad, or a little more than $\frac{1}{6}$ of the length of the head. The horizontal diameter of the pupil is ·52 inch. The three operculums, the supra-orbital, suborbital, and prefrontal, as well as the remarkable maxillary bones, possess a radiated structure on their surface, which is covered with a very thin skin, breaking with the least touch.

The frontal and nasal bones are smooth and covered with skin of a dark steel colour, showing the same iridescence as the former.

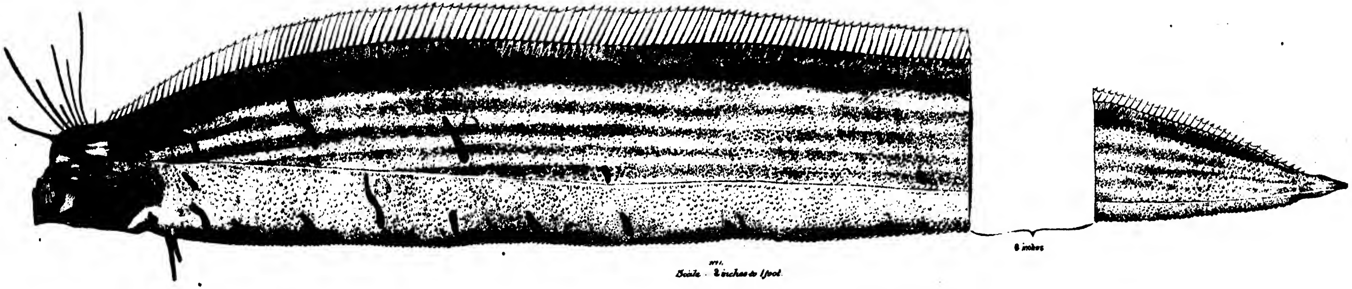
The cheeks, the supra-scapular and temporal bones are covered with tuberculated skin which has also the same dark bluish colour as the rest of the head.

The dorsal fin consists of two portions, of which the first nine spines form a crest. These spines enlarge at their termination to a lobe, as shown by the two only perfect ones when the fish was obtained; they cover a space of 2·5 inches. The first of these spines is broken off at 8 inches from the base; it is the stoutest of the whole series.

No. 2 is considerably thinner and 7 inches long. It is one of the complete ones. The next three spines (3, 4, and 5) were all broken off at 4 to 6 inches and were nearly as thick as the first. From here they get thinner, the thickness of the seventh having only the thickness of the second. This spine which is entire, is 7·75 inches long, and has, like the second, a lobe at its termination. The eighth is still thinner and broken

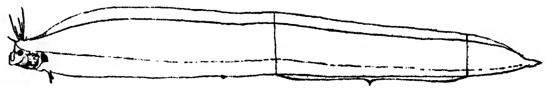
REGALECUS PACIFICUS. von HAAST.

DRAWN BY LL. POWELL, M.D., F.L.S.



No. 1.
Scale 2 inches to 1 foot.

No. 2.
Snout protruded.



No. 3.
Outline. Scale ½ inch to 1 foot.

Photo-lithographed from the original coloured drawing.

off one inch from its base, and there is only a fragment of the ninth, which is not thicker than one of the rays of the dorsal fin proper. All of these spines which have minute hooks directed upwards on their anterior and posterior edges are united with each other by a small membrane about ·45 inch high. They had, like the two ventral rays, a red colour, very bright in their upper portion when the fish was first obtained, which, however, gradually faded to a dull light pink.

A quarter of an inch behind the last spine the dorsal fin proper begins, consisting of a great number of slender rays, which do not project beyond the margin of the thin membrane by which they are united. These rays stand at a distance of three-quarters of an inch from each other. At the beginning they are about one inch high, gradually increasing in length, till about one foot from the beginning of this dorsal fin they stand 2·5 inches high, continuing so to within 3 feet from the end of the tail; they after this gradually get smaller, till 5·5 inches from the end of the tail, they cease altogether. Here at the termination the last four rays stand not only above the membrane, but they are also thicker than all the preceding ones. The pectoral fin is one inch broad at the base; 2·5 inches high along the first ray. It also had a reddish hue, but not so bright as the crest and the ventral rays.

In a straight line below the hind edge of the pectoral fin stands a single strong ventral ray on both sides, of which, however, only 3 inches are preserved, the rest being broken off.

I was informed by the finder that it had been at least 15 inches long, but he did not observe any enlargement at the termination. I believe that, when the fish was first seen, the anterior portion of this remarkable ventral ray with the lobe had been already broken off during the efforts the fish made to regain the sea.

Tail without any caudal fin, being formed by a number of spines, getting gradually thinner and tending to a point.

Anal vent 4 feet 1 inch behind the ventral spines.

The lateral line is formed by a number of elongated smooth scales, which lie in a groove. It starts from the posterior end of the supraorbital, gradually descending, so that at the anus it is situated only 3·5 inches above it. Four longitudinal ridges which are cut off obliquely by the lateral line extend along the whole length of the body, they are covered with small round tubercles and are about three-quarters of an inch broad, the space between them having nearly the same breadth. This space is also covered with tubercles, which, however, are very minute. Below the latter the intermuscular septa are situated. The skin below the lateral line is almost smooth for about an inch, after which the tubercles appear again, getting

gradually more numerous and larger, till we reach the ventral line, where they become very large and well raised, possessing in the posterior half a small hook turned backwards.

Postscript, 22nd December, 1877.—The following account taken from a New Zealand newspaper about the middle of July, 1877, shows that another specimen of *Regalecus* has been washed ashore on the west coast of this island. From the short description in that paragraph it appears that the fish in question is either a specimen of *Regalecus pacificus*, or at least belongs to a nearly allied species, the main difference being that the first portion of the dorsal fin in the west coast specimen has ten spines instead of nine as in the former. It is also interesting to observe that each of the two strong ventral rays was two feet long, but no data are given from which we can conclude that they were intact:—" An extraordinary fish was picked up on the Little Waimangaroa beach, Karamea District, by Mr. Alexander McDonald, on Tuesday last, of which the following description is furnished by the Westport Times:—Length, 14 feet 4 inches; girth, 2 feet 7 inches; one dorsal fin extending from head to tail; from the top of the head there extended ten feelers, each one foot in length, and two similar appendages, about two feet in length, grew underneath the jaw, resembing in appearance the feelers of a lobster; on each side of the head there was one small fin, and the gills of the fish resemble those of a turbot; the body was of a bright silvery hue and covered with fine scales, the shape of the body being more flat than round; the eyes resembled those of a cod-fish. When found it had only recently been stranded, as it was not quite dead. This is probably some large species of frost-fish."

Art. XXXII.—*On the Habits of the New Zealand Grayling.* By J. Rutland.

[*Read before the Otago Institute, 5th June,* 1877.]

Hearing that very little is positively known of the habits of the New Zealand grayling, I have collected information from various quarters, which, together with the results of my own observations, I now communicate.

My attention was first directed to the grayling in 1858. Being then resident in the Waimea (Nelson) I was informed that during the winter months large numbers of these fish came into a small brook which ran close to my house. This brook, about thirty feet wide, after draining part of the flat bush land of Waimea South, emptied itself into the Waiti, a tributary

of the Waimea river. Except where it passed through large swamps in the bush it consisted of a series of deep pools and shallow rapids, and was everywhere overshadowed either by the forest trees or with flax and *Veronica* bushes. In June I saw the first grayling; they came in shoals, evidently intent on making up stream,—a mixed lot of fish, the smallest from six to seven inches, the largest about twelve inches in length. A mill-dam a little higher up than where I lived prevented their progress for some days, and gave me an opportunity of capturing a great many.

I noticed that both the large and small fish contained roe, and that they had a peculiar habit of congregating in the deep water, packing themselves close together near the bottom. When disturbed they scattered, but in a few minutes again collected on the exact spot from whence they had moved. In July or August I saw a few straggling fish, apparently making down stream, but I failed to get any at that time.

On two occasions during autumn I saw grayling in the larger rivers of the Waimea, once in the Waiti near its junction with the Waimea, and once in an overflow of the latter about two miles from the sea. On both occasions the fish were in shoals, but swimming apart, not huddled together as in the brook.

Now turning to the Wairau river (Marlborough), which is in every way similar to the Waimea river, except in being larger and draining a much less wooded country, I find the grayling here with precisely the same habits. From the Onomorutu, a small bush tributary, where, during the winter months cart-loads of these fish were formerly taken, I have collected information. The appearing and disappearing at the same time of year, the crowding together at the bottom of deep shady pools, and the bulk of the fish being full of roe, correspond with my own observations in the Waimea. From this I think we may safely conclude that in this portion of the island the grayling during the winter leaves the large open rivers and enters the small sheltered streams for the purpose of spawning. But from whence do they come to reach those streams? From the sea or the upper waters of the large rivers? From the Maitai river (Nelson) I have collected information which I think may answer the question.

Mr. G. Smith, who resides on the banks of that stream five miles out of Nelson informs me that the grayling make their appearance in February, always coming up the river in shoals. They remain till the middle or end of winter and then entirely disappear. During the last three years they have become very scarce, which he attributes to the introduction of the trout. Mr. Norgrove, who formerly resided in Nelson, thus writes,—"I have taken the grayling in the Maitai, just where the tide breaks into the fresh water, in large quantities, and as much as four miles higher up, always

in shoals. About the month of March they go up to spawn. I have fished at the mouth of the same river at all seasons in the salt water and caught lots of so-called herrings, which are, I believe, a kind of mullet, but never caught a single grayling at any time. They remain about a month, and then not one to be seen higher or lower."

Notwithstanding this negative evidence obtained from Mr. Norgrove, I am still inclined to think that the grayling does resort to the sea. When I consider the small size and nature of the Maitai river, I cannot otherwise account for their disappearance during a portion of the year. From its source in Landtrap Gully to its mouth is a straight line for from seven to eight miles, running over a rocky floor the greater portion of that distance. How could immense numbers of fish such as were formerly found conceal themselves, and again, where are the small fish? No one seems ever to have seen grayling less than six inches in length, nor have the large fish been seen except in shoals.

From a still smaller stream, the Waitohi, in Picton, where grayling have been taken, I endeavoured to procure information, but could not get such as I could rely on. It is impossible to observe their habits in the large rivers, such as the Wairau, Pelorus, or Waimea, owing to their rising amongst inaccessible mountains, but wherever they have been seen it has been in shoals always making up stream.

The sea-mullet ascends the Pelorus river during very warm weather, five or six miles above the tide-way. On one occasion in the autumn in a net set for them I caught some grayling which seemed to have been swimming along with the mullet. In this river they do not enter any of the small back streams but confine themselves to the Rai Valley branch and the main stream. This may be owing to the river being surrounded with bush from its mouth to its source. They can therefore find shelter wherever they go.

Such is the information I am able to furnish. It leaves the question, Is the grayling a fresh-water fish? unanswered, but it may assist in throwing some light on their habits.

Art. XXXIII.—*Supplementary Description of Species or Varieties of* Chrysophani (Lepidoptera rhopalocera) *inhabiting New Zealand.*

By R. W. Fereday, C.M.E.S.L.

Plate VIII.

[*Read before the Philosophical Institute of Canterbury, 2nd August, 1877.*]

In the last volume of our "Transactions"* will be found some "Brief observations on the genus *Chrysophanus*, as represented in New Zealand,"

* "Trans. N.Z. Inst.," IX, 460.

indicating certain characters and circumstances which appeared to afford reasonable ground for treating several of the New Zealand forms of *Chrysophani* as distinct species or varieties.

Not having had time to complete the coloured drawings intended to illustrate the several forms, I promised to prepare such drawings and to give a full description in a future paper, and I now fulfil that promise.

The several letters—A, B, C, D, E, F and G—used in my former paper to indicate the different forms, will be now used to indicate the like.

CHRYSOPHANUS SALUSTIUS, *Fab.*

B. *Male: Primaries.*—Broad; costa slightly rounded towards the apex and considerably so at the base; hind margin uniformly convex.

Upper side.—Fulgid golden-copper, dusky at the base; the dusky shade not extending to the discoidal dots; two black dots before the middle, the one being in the discoidal cell and the other between the medial and anal nervures; a black quadrate patch on the false nervure closing the discoidal cell; beyond the middle and midway between the quadrate patch and the submarginal band, a curved and rather narrow black band disrupted by the intersection of the nervures; a submarginal black macular band, the maculæ more or less confluent; hind margin bordered with black; the border and submarginal band contiguous towards the anal angle, and confluent towards the apex where they expand and form a broad termination on the costa; nervures slightly bordered and in some individuals slightly irrorated with black; cilia pale fulvous.

Under side.—Luteous; the base, costa, hind margin, and apex, pale dull yellow blending with the luteous; the discoidal black dots and quadrate patch as on the upper side, the latter formed of two confluent spots, the first band beyond the patch represented by seven (occasionally eight) roundish black spots, and the spot between the externo-medial and sub-externo-medial nervures being (in some individuals) blotched outwardly, and the two between the subexterno-medial and anal nervures being didymous; the maculæ of the submarginal band diminish in size from the anal angle towards the apex where they become obsolete; cilia pinkish-orange.

Secondaries: Upper side.—Fulgid golden-copper, dusky at the base and inner margin; a dusky dot in the discoidal cell towards the base; a black patch closing the discoidal cell, midway between which and the submarginal band is a rather narrow irregular curved black macular band; the maculæ of the latter band sagittate; hind margin bordered with black, the black border and submarginal band being confluent towards the anterior margin; cilia pale fulvous.

Under side.—Saffron or cadmium-yellow; the maculæ of the upper side being repeated, but very obscure; cilia pinkish-orange.

A. *Female.*—Similar to the male, except that on the upper side of the wings the nervures are more irrorated with black, the basal shade extending to the discoidal dots, the dark bands broader (the sub-marginal bands especially so), and the maculæ thereof more united, the maculæ of the sub-marginal band having pale-violet lunular pupils very distinct on the secondary and less so on the primary wing, the lunules becoming obsolete as they approach the costa of the primary wing. In some individuals the violet lunules are more or less obsolete or entirely absent.

The figures B and A respectively represent the upper side of the male and the upper side of the female—B representing the body and right wings of the male, and A the left wings of the female. Figure 2 represents the under side.

Expanse of wings—1 inch 2 lines.

Hab. New Zealand.

Time of appearance: December to March.

Frequents grassy places, particularly sunny banks; seems to be distributed over most parts of the South Island, for I have met with it in all localities I have visited. I cannot say with certainty if it is found in the North Island. Mr. Butler, of the British Museum, informs me that the female was described by Fabricius as *salustius*, and by Doubleday as *edna*, and consequently the Fabrician name *salustius*, being the earlier, will take precedence. Neither Fabricius nor Doubleday mention the violet pupils of the maculæ of the sub-marginal band; but possibly the pupils were absent in the specimens they described, for some individuals in my possession have the pupils nearly obsolete.

There is an error in the printing of my former paper,* which materially lessens the force of the passage. The word *copulâ* should be in the place of "company."

C. MAUI, *Fereday.*

C. *Male.*—I can add but little to what I have written in my former paper as to the distinctive characters of this form, but that the secondary wings are more produced and angular at the anal angle than in any of the other forms, with the exception perhaps of form E (male), the secondaries of which have nearly the same angle; the maculæ of the sub-marginal band are more separated than in the other forms, the two between the sub-externo-medial and subinterno-medial nervures of the primaries and the three nearest the anal angle of the secondary wings being very conspicuous and somewhat rounded, the others being more or less obsolete in different

* *Loc. cit.*, 461, line 29.

individuals. In some individuals the maculæ of the band beyond the middle on the upper side of the primary wings are obsolete, the under side of the wings of some examples is nearly similar in colour to the under side of the wings of *C. salustius*, but in general the yellow is more sordid and the markings of the secondaries more distinct (as shown on Pl. VIII, fig. 1).

Fig. C. represents the upper side of the male and fig. 1 the under side The female I have not yet seen, the few specimens taken by me having been all males.

Exp.—1 inch 8 lines.

Hab. Wellington and Hawke Bay.

Time of appearance: February (and probably in spring).

Taken flying in open clearing in bush.

C. FEREDAYI, *Bates.*

D. *Male and Female.*—Mr. Bates' description,* and the observations in my previous paper, sufficiently indicate the distinctive characters of this form. Fig. D. represents the upper side of the male and fig. 3 the under-side.

Exp.—1 inch 8 lines.

Hab. Mount Torlesse Station and Kaiapoi, Canterbury.

Time of appearance: December to March.

C. RAUPARAHA, *n. sp.*

E. *Male.*—The following may be added to the description contained in my former paper:—

Primaries.—Narrower than in any of the other forms; costa very slightly concave beyond the middle, rounded towards the tip and abruptly so at the base. Hind margin much more oblique than in any of the other forms, and slightly concave near the anal angle.

Upper side.—Fulgid copper, but not so bright and glistening as *C. salustius* or *C. maui;* dusky at the base; the discoidal dots, quadrate patch, and bands black; bands narrow and maculæ small, but not so much so as in *C. maui;* the sub-marginal band very broad towards the costa, and, conjoined with the border of the hind margin forms a broad dark tip; nervures black, and more narrow than in the other forms; cilia dark fulvous.

Under side.—Disc luteous, the base and along the costa fuscous, and also a fuscous border on the hind margin; very broad at the apex, and narrow towards the anal angle; the discoidal dots, quadrate patch, and sub-marginal band represented as in the other forms, but the maculæ less rounded; cilia pinkish-brown.

* "Ent. Mo. Mag.," IV., 53.

Secondaries.—Anal angle rectangular.

Upper side.—Same colour as upper side of primaries; dark markings, similar to those of form B., but less distinct, and the dark border and sub-marginal band not confluent towards the anterior margin; cilia dark fulvous.

Under side.—Fuscous; the markings of the upper side repeated, but very indistinct; each macula of the sub-marginal band bears a pale lunule, and has also a pale outward margin; cilia pinkish-brown.

Fig. E. represents the upper side of the male and fig. 4 the under side.

Exp.—1 inch 8·5 lines.

Hab. Kaiapoi Bush, Canterbury.

Time of appearance: December and January.

I discovered this form at Kaiapoi Bush, where it was not uncommon before the bush was destroyed. I know of no other locality where it has been seen or taken.

(?) C. RAUPARAHA.

F. *Female.*—This, as stated in my former paper, I believe to be the female of form E.

Exp.—1 inch 4 lines.

Hab. One specimen taken at Kaiapoi Bush and one at Fendalltown, near Christchurch.

Time of appearance: January.

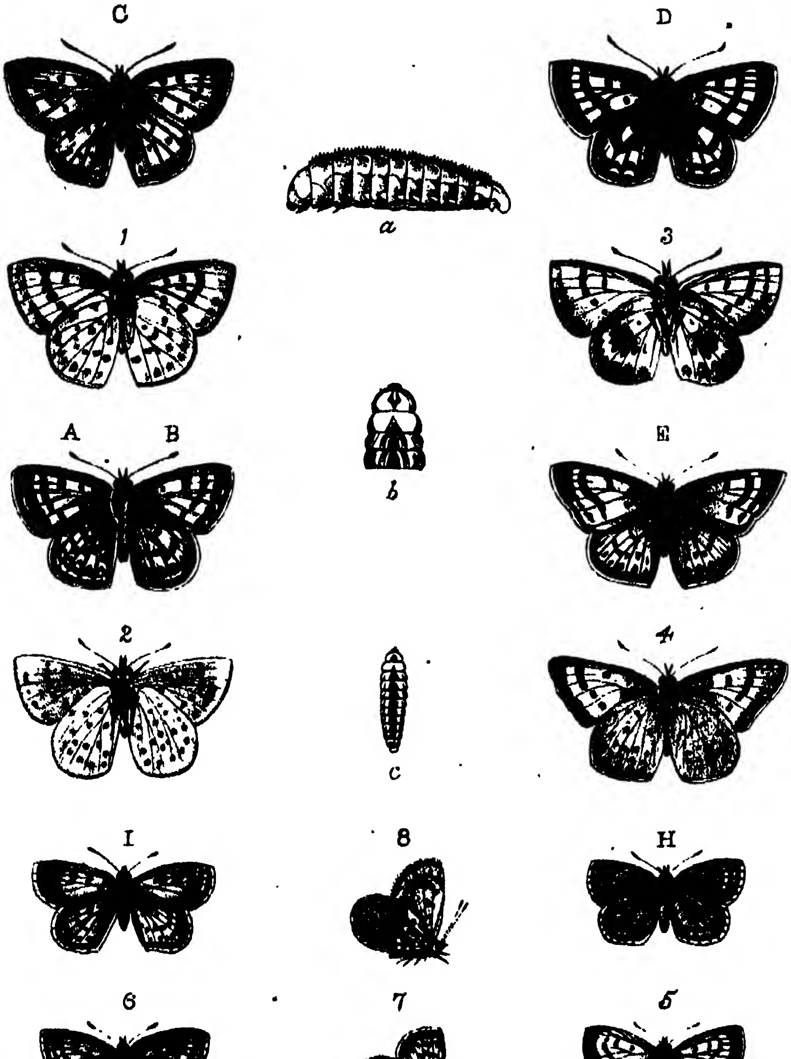
C. BOLDENARUM, *White.*

G.—I have two or three varieties, and am not quite clear as to which Mr. Butler's description, in his "Catalogue of *Lepidoptera* of New Zealand," p. 8, refers. The figures 8 and 9 in plate at the end of his catalogue most nearly agree with the variety found (or formerly found, for I have not seen it for some years past) within the city of Christchurch, on some flat sandy waste ground. Mr. Butler, referring to the figures, states, "the bands and spots on the under-surface of secondaries have been made altogether too dark," which is not the case with the Christchurch specimens, the latter being generally darker than shown in Mr. Butler's figure, though some individuals are not quite so dark.

The varieties appear to be due to locality, as the individuals of each locality vary but little.

There are three localities where I have taken this insect, namely, Christchurch; Drayton Station, on the plains near Mount Hutt; spurs of mountains near Castle Hill Station; and the top of the Mount Hutt range—all in the Canterbury province.

The distinctive characters of the varieties may be better understood by the following tabular arrangement.



R.W.Fereday, del. *To illustrate paper by R.W.Fereday.* J.B. lith.

Christchurch.	Drayton Station.	Mount Hutt and spurs of mountains near Castle Hill Station.
Male. *Primaries.* *Upper side:* Dark dusky brown mingled with fulvous; disc shot with glistening purple	Same as Christchurch form	Reddish-fulvous, irrorated with dark dusky brown. Otherwise same as Christchurch form.
Costa and base of principal nervures irrorated with golden yellow	Same as Christchurch form	
A more or less indistinct sub-marginal band of black ill-defined spots, upon the inner side of which are bright spots of violet; in some specimens a few small dots of violet represent a marginal series ..	Do.	Marginal series of violet dots distinct, otherwise same as Christchurch form.
A more or less indistinct curved discal band of black ill-defined spots, followed in some specimens by fulvous dashes	Do.	Curved discal band very distinct, the spots rather arched, otherwise same as Christchurch form.
Cilia, brownish dirty grey	Do.	Same as Christchurch form.
Under side: Tawny; sub-marginal band of blackish spots bordered externally and internally with white	The tawny colour paler and more dirty; the spots of the sub-marginal band dark grey, with a patch of white on each spot	Pale ochreish-yellow, in other respects same as Drayton form.
Secondaries. *Upper side:* Dark bronzy brown; markings not visible..	Dark bronzy brown; a dot in the discoidal cell and a patch closing the cell; a curved discal and a sub-marginal macular band and a dark marginal border; the bands and border dusky black, and in the intervening spaces are indistinct fulvous spots, those between the marginal border and the sub-marginal band being reniform; all the markings more or less indistinct in different individuals	Reddish-fulvous; the basal portion of the disc shot with purple; the dot and patch in discoidal cell same as the Drayton form; the maculæ of the discal band arched; the maculæ of the sub-marginal band wedge-shaped and with small violet pupils; all the markings distinct and well defined.

Christchurch.	Drayton Station.	Mount Hutt and spurs of mountains near Castle Hill Station.
Male.		
Under side: Ground colour varying from grey to brown; a broad and very irregular transverse central shade of deep rich brown, approaching to black in some specimens, and edged with white; a sub-marginal band of black roundish spots, each spot margined externally with white and inwardly with a white supercilium immediately followed by a brown one; several sub-basal discoidal spots of dark brown or black edged with white upon a brown ground; all the markings very distinct	Markings pale, and varying from a silvery to an ochreish-grey tint	Pale grey markings very indistinct.
Female.		
Primaries.		
Upper side: Dusky fulvous; not shot with purple; markings similar to those of the male; the violet spots obsolete or nearly so	Rich bronzy brown; the violet spots very bright and distinct; cilia much whiter grey than in the Christchurch form, and distinctly chequered with dark ..	Pale fulvous; in other respects similar to the Drayton form.
Under side: Paler, and sub-marginal spots more obscure than in the male, otherwise similar..	Similar to male	Similar to male.
Secondaries.		
Upper side: Same colour as primaries; markings similar to those of secondaries of male of Mount Hutt form, only more obscure and without the violet pupils	Same colour as primaries; markings similar to the Christchurch form, only less obscure	Same colour as primaries; markings similar to those of secondaries of the Mount Hutt form.
Under side: Markings more or less obscure and general colour browner than that of the male, otherwise similar	Similar to male of Christchurch form, only that the central shade is narrower; markings very bright	Similar to male.
Exp.: Male, 10''' to 11½'''; Female, 10''' to 10½'''	Exp.: Male, 9½''' to 11'''; Female, 10½'''	Exp.: Male, 9''' to 11'''; Female, 9½''' to 11½'''.
Time of capture: December*	Time of capture: January and February*	Time of capture: Jan. and Feb.*

Fig. H represents the upper side of the female of the Drayton form.
" 5 " the upper side of the male.
" I " the upper side of the female of the Mount Hutt form.
" 6 " the upper side of the male.
" 7 " the under side of same.
" 8 " the under side of the male of the Christchurch form.

* The times of capture given here are when the specimens were taken, being the only times I visited the localities.

If the Mount Hutt or the Castle Hill form is a distinct species, as it possibly may be proved to be, I propose for it the name of *Tama*, after a traditionary Maori chief of that name; and should it be held to be a variety only, the name will serve to distinguish it as the mountain form.

The individuals of the Mount Hutt and Castle Hill form were taken in places where *Donatia novæ-zealandiæ* grows, and seeing them hovering about and settling upon patches of that plant in a manner indicating the deposit of their eggs, I carefully searched the plants, and succeeded in finding one larva, of which I made a coloured drawing and wrote out a description. The description has unfortunately been mislaid, but the drawing, a copy of which accompanies this paper, I have preserved. From the drawing and from recollection, I give the following description of the larva :—

Onisciform; pubescent; pale green; dorsal line consisting of a dark purplish-brown conical spot on the fourth and following segments, the apex of each cone pointing towards the head and joining the base of the preceding one at the joint of the segment, the cones margined with white; outside and round the white is a margin of dull red; on the side a row of pale pinkish oblique stripes, blended on the lower side with dull red; the red extending thence to below the spiracles, except on the posterior side of each segment, where a green colour intervenes and is blended with the red; the angles formed by the oblique stripes are shaded with a dark colour. On the second segment is a dorsal diamond-shaped dark purplish-brown spot, with a longitudinal streak of white in its centre. I kept the larva for some time, and fed it upon *Donatia*, hoping to obtain from it a pupa and imago, but, after being apparently full-fed and retreating to the root of the food-plant, it died, without assuming the pupa state. One egg, which I also found at the same time, did not produce a larva.

Fig. *a* represents the larva magnified; *b*, head front segments, also magnified; and *c*, the natural size.

The larva is so characteristic of the genus that there can be little doubt it would have produced a specimen of the Castle Hill form, had it lived and passed through its changes to maturity. I know of no other insect to which it could belong; but there is not sufficient evidence to determine the fact.

Art. XXXIV.—*Description of new Genera and Species of* Psychidæ. By R. W. Fereday, C.M.E.S.L.

Plate IX.

[*Read before the Philosophical Institute of Canterbury, 6th December, 1877.*]

Liothula, n.g.

[From λεῖος "smooth," and θυλαξ "a case."]

Male.—Head small; head and thorax pilose; proboscis none; palpi obsolete; antennæ as long as the thorax, bipectinate, the branches very long towards the base, from whence to beyond the middle the branches abruptly decrease in length, and thence gradually decrease to the tip; body robust; abdomen extending more than half its length beyond the hind wing; stout near the thorax and tapering thence to the tip; legs slender; femora and tibiæ pilose; fore-wings diaphanous, thickly clothed with scales, narrow, nearly straight along the costa, slightly rounded at the tips, hind margin very oblique; discoidal cell closed by a transverse angular nervure, the angle of which projects inwards; median nervure emitting four branches, the branches nearly equidistant from each other, the second springing from the first at the point of junction of the transverse nervure. Between the median nervure and the inner margin are two nervures which unite in the disc and form one nervure from thence to the hind margin; discoidal cell divided longitudinally by two rather indistinct veins; hind-wings with discoidal cell closed by a transverse irregular nervure and divided longitudinally by a forked vein; median nervure emitting four branches, the first of which springs from the second at about one-third of the length of the latter, which is abruptly curved at its base; the second branch about twice further from the third than from the first.

Female.—Apterous.

I cannot, from authorities at hand, find a description of any genus of this family entirely applicable to this insect. The nearest appears to be the genus *Metura*, described in the Catalogue of Lepidoptera in the British Museum.

Liothula omnivora, n.s.

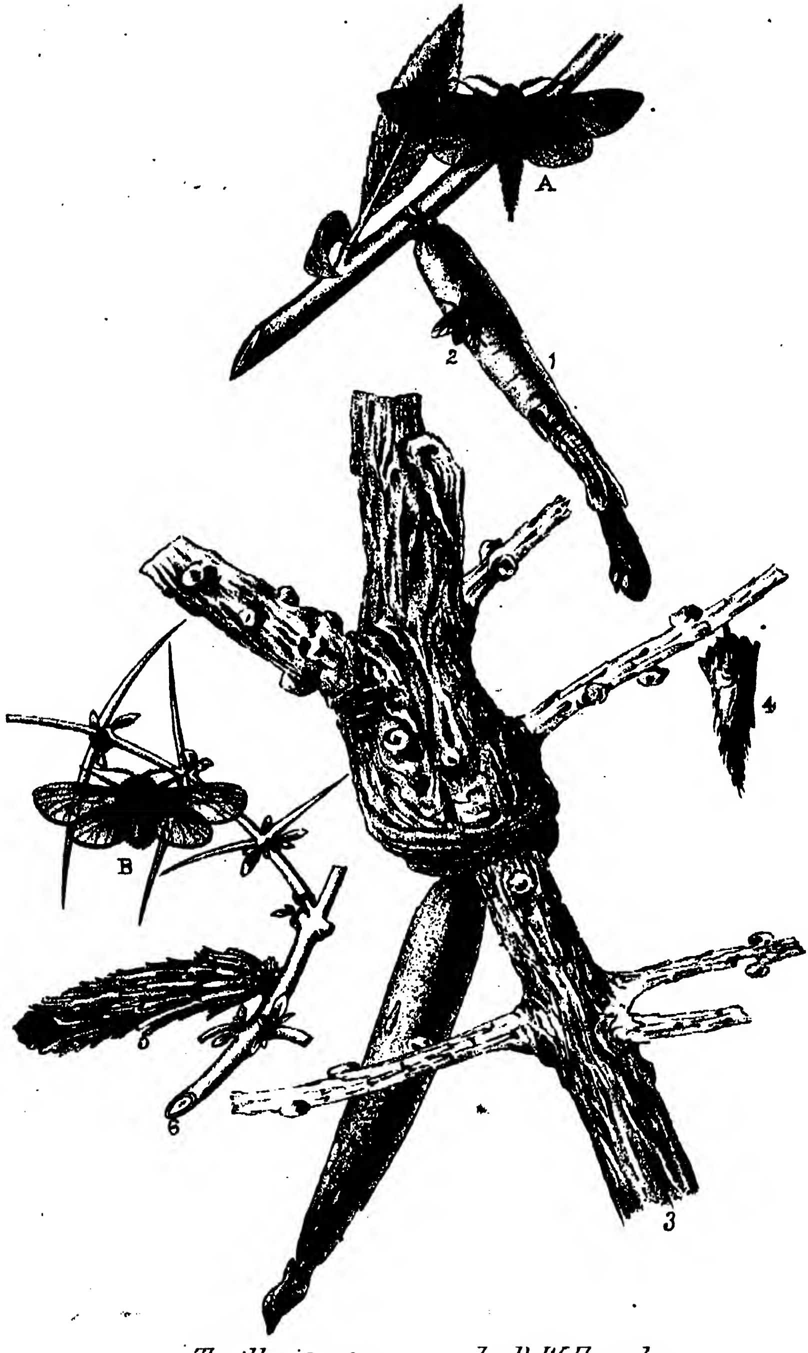
Male.—Fuliginous.

Expanse of wings—14·5 lines.

Length of body—8 lines.

Hab.—Canterbury, New Zealand, especially in the neighbourhood of Christchurch.

Fig. A represents the male perfect insect. Larva varying from light to dark dull brown, mottled with dirty white, sometimes with a pinkish



R. W. Fereday. del. *To illustrate paper by R. W. Fereday.* J.B. lith.

shade. Head and three first segments retractile. The cases of full-fed larvæ vary in size from 1½ to 3½ inches, long, narrow, and tapering, colour varying from light to dark grey, generally smooth but sometimes ornamented with pieces of twig or leaves laid on longitudinally in somewhat regular order, inside thickly lined with fine brown silk. The case is exceedingly tough. I have tested its strength and found that fracture takes place at 32 lbs. The larva is found feeding on all kinds of trees and shrubs, both evergreen and deciduous, not even rejecting the common laurel, and I have named the insect *omnivora* on that account. I noticed it first on willow trees, when I came to the colony in 1862. Willow, wattle, and coniferous trees appear to afford a particularly favourite food. The cases found on the willow and wattle are generally smooth and plain, but those on the coniferous trees are frequently embossed with small pieces of twig and foliage laid on longitudinally in an order that seems to indicate design. Until fully grown the larva moves about with the case from leaf to leaf feeding with its anterior segments and prolegs extruded. Attached to the interior of the mouth of the case are silken threads which the larva, when disturbed, draws so as to close the orifice. The larva before assuming the pupa state fixes the case by repeated bindings of silk round a twig, as shown in plate IX., on firmly attaching it to the trunk of the tree. The larva whilst feeding suspends the case by a thread. The case is very small at first, the larva commencing to form it soon after birth; and, as the larva increases in size, so is the case enlarged, the larva adding to it from time to time as a mason builds a chimney. Fig. 1 represents a case fixed to a twig of willow with the pupa skin extruded; fig. 4, a case containing a partly-grown larva as suspended when at rest.

Notwithstanding the security afforded by the case, a dipterous insect (somewhat resembling a common bluebottle-fly, but not larger than a common house-fly) is very destructive to the larva. I have found as many as nine out of every ten cases filled with the cocoons of the fly. The fly (fig. 2) is represented at rest on the case.

I find the cases have become much less common in my garden than formerly, which I attribute to the increase of birds.

Fig. 3 represents a portion of the branch of a larch fir, with a case of this insect attached. The silk wound round the branch prevented the return of the sap, and caused an extraordinary swelling of the upper part of the branch. It was found by Mr. James Townsend, at Christchurch.

OROPHORA, *n.g.*

[From *ὀροφή* "thatch," and *φορεῖν* "to bear," alluding to the case being covered with pieces of grass in the manner of thatch.]

Male.—Body stout, extremely lanate; head small, not prominent; palpi

obsolete; antennæ rather longer than the thorax, ciliated, tapering to the tips; abdomen not extending beyond the hind-wings; fore-legs longer than the others, slender, almost bare; wings broad, diaphanous, thinly covered with hairs; fore-wings slightly concave along the costa, hardly oblique along the hind margin, rounded at the anal angle; discoidal cell closed by a transverse angular nervure, the angle of which projects inwards; median nervure emitting four branches, the first of which springs from an abrupt bend in the second at the junction of the transverse nervure, the second about a third further from the third than from the first. Between the median nervure and inner margin are two nervures which unite in the disc, and form one nervure from thence to the hind-margin. Of these two nervures the one farthest from the hind-margin is hardly visible towards the base. Hind-wings with discoidal cell closed by a transverse angular nervure, and divided by a vein springing from the angle of the transverse nervure; median nervure emitting four branches, the first of which springs from the second at about a third of the length of the latter, which is abruptly angulated at its base; the second branch more than half further from the third than from the first.

Female.—Apterous.

Not finding its generic characters entirely agree with any of the descriptions in the British Museum catalogue, I have described a new genus for this insect as above.

Orophora toumatou, n.s.

[From the specific name of the shrub upon which the cases are found.]

Male.—Ochreous grey; the long hairs on the body and base of the wings tinged with pale ochreous.

Expanse of wings—12·5 lines.

Length of body—5 lines.

Hab.—Canterbury plains.

Fig. B. represents the male perfect insect.

Larva.—I have never seen the larva when full-fed. Its case measures in length about sixteen lines; the exterior covered with pieces of stems of grass, from a line to five lines in length, laid on longitudinally and in the manner of thatch; the interior thickly lined with fine silk. The cases are found fixed to twigs of wild Irishman *(Discaria toumatou)*, but it may be inferred, from the covering of the cases, that it probably does not feed on the shrub but upon the tussock-grass generally growing where the shrub is found. It is some years since I found the cases on *Discaria toumatou*, growing in the river beds of the Rakaia and Waimakariri, on the Canterbury Plains, and I did not find any case in its earlier stage before the larva had fed up and changed to the pupa state.

Fig. 5 represents a larva case of this insect affixed to a twig of *Discaria toumatou* (fig. 6).

I have never met with any of these insects on the wing; all my specimens have been bred from cases.

ART. XXXV.—*On the Butterflies of New Zealand.* By ARTHUR G. BUTLER, F.L.S., &c. Communicated by JOHN D. ENYS, F.G.S.

Plate XII.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

OF the fourteen species of Rhopalocerous Lepidoptera hitherto recorded as unquestionably occurring in New Zealand, exactly one half appear to be endemic forms; of the remaining seven, six are probably of Australian origin, or at any rate are common to Australia and New Zealand, whilst the remaining species is of American origin.

In the present paper it is proposed, where necessary, to give the synonymy of each of the species, with a short description and with one or more figures; so that by reference to this little memoir the collector may be enabled to recognize without difficulty any New Zealand species which he may obtain.

LEPIDOPTERA.

Section *Rhopalocera.*

The term *Rhopalocera*, as applied exclusively to the butterflies, is a mere convenience, and does not (as has been falsely stated by some lepidopterists) express any constant distinction between butterflies and moths; indeed, these groups are only to be distinguished by family characters, such as the structure and habits of the larvæ, the form and economy of the pupæ, and the habits, form of venation, or other structural peculiarities of the imago; the same characters do not hold good as distinctive marks throughout the moths, and thus it happens that some genera are in a wretcted state of "limbo," neither accepted as butterflies by the student of that group, nor permitted to rest peacefully among the moths.

Butterflies therefore are not all "club-horned," some have clubs, some have filiform antennæ, some have moniliform and subserrated antennæ. In the *Hesperiidæ* alone you have any amount of variation of structure—clubs, hooks, whips, spoons; all indicating a mere generic distinction and not differing from the same organs in such families as the *Sphingidæ*, *Carteriidæ*, and *Agaristidæ*. The term *Rhopalocera* therefore is used to indicate the five highest families of the Lepidoptera—the *Nymphalidæ*, the *Erycinidæ*, the *Lycænidæ*, the *Papilionidæ*, and the *Hesperiidæ*.

As the entomologists of Australia and New Zealand do not seem thoroughly to comprehend why the *Nymphalidæ* (and not the *Papilionidæ*) are now placed at the head of the butterflies, we shall here quote from Mr. Bates's admirable paper in the Journal of Entomology for 1864, and they will then see that this renowned lepidopterist has arranged the five families in a perfectly gradational and natural series. He has not followed Linnæus in choosing the *Papilionidæ* to commence with because they are big, and the *Hesperiidæ* to conclude with because they are little, but he has studied the structure of each family from the larval to the perfect condition.*

"*Family* 1. Nymphalidæ. Front legs imperfect in both sexes; in the female wanting the tarsal claws; in the male the fore tarsi quite rudimentary, consisting of one or two spineless joints. Pupa suspended freely by the tail.

a. Lower disco-cellular nervule of the hind wing perfect.

Subfamily 1. *Danainæ*. Larvæ smooth, with fleshy processes. Fore-wing submedian nervure of the imago double at its origin. (This subfamily includes the greater part of the *Heliconidæ* of authors).

Subfamily 2. *Satyrinæ*. Larvæ with bifid tails, spineless. Palpi of the imago generally compressed and fringed with long hair-scales.

Subfamily 3. *Brassolinæ*. Larvæ generally with bifid tails, spineless. Hind wing of the imago furnished with a prediscoidal cell.

Subfamily 4. *Acræinæ*. Larvæ studded with branched spines. Palpi of the imago thick and scantily clothed with hair.

Subfamily 5. *Heliconinæ*. Larvæ studded with branched spines. Palpi of the imago clothed with fine scales, and hairy in front.

b. Lower discocellular nervule, at least of the hind wing, more or less atrophied.

Subfamily 6. *Nymphalinæ*.

Family 2. Erycinidæ. Six perfect legs in female; four in male; the anterior tarsi consisting only of one or two joints and spineless.

Subfamily 1. *Libythæin* . Pupa suspended freely by the tail.

Subfamily 2. *Stalachtinæ*. Pupa secured rigidly by the tail in an inclined position without girdle.

Subfamily 3. *Erycininæ*. Pupa recumbent on a leaf or other object, and secured by the tail and a girdle across the middle.

Family 3. Lycænidæ. Six perfect legs in female; four in male; the anterior tarsi wanting one or both of the tarsal claws, but densely spined beneath. Pupa secured by the tail and a girdle across the middle.

Family 4. Papilionidæ. Six perfect legs in both sexes. Pupa secured

* Compare Scudder "On the Classification of Butterflies," Trans. Am. Ent. Soc., 1877, pp. 69–80.

by the tail and a girdle across the middle. (The true *Papiliones* have a leaf-like appendage to the fore tibiæ—a character which approximates the family to the *Hesperidæ* and moths.

Subfamily 1. *Pierinæ.* Abdominal margin of the hind wing not curved inwards.

Subfamily 2. *Papilioninæ.* Abdominal margin of the hind wing curving inwards.

Family 5. HESPERIDÆ. Six perfect legs in both sexes; hind tibiæ, with few exceptions, having two pairs of spurs. Pupa secured by many threads, or enclosed in a slight cocoon."*

Excepting that a few sub-families have been added, this arrangement remains in its entirety, and is the basis of the classification adopted by all the rising generation of European lepidopterists.

The butterflies of New Zealand are at present restricted to three of the five families—*Nymphalidæ*, *Lycænidæ*, and *Papilionidæ*.

Family Nymphalidæ, *Westwood.*

This group is represented in New Zealand by three subfamilies—*Danainæ*, *Satyrinæ*, and *Nymphalinæ*.

Subfamily DANAINÆ, *Bates.*

Danais, *Latreille.*

1. *Danais archippus.*

Papilio archippus, Fabricius, Spec. Ins., p. 55, n. 243 (1781).

"Alis repandis fulvis venis margineque albo punctato nigris: anticis maculis apicis fulvis: habitat in Americâ Meridionali."†—*Fabr.*

I have not thought it necessary to quote the full synonymy of this introduced species: if required, it will all be found in Kirby's "Synonymic Catalogue."

Mr. Charles V. Riley, in his "Third Annual Report of the noxious, beneficial, and other Insects of the State of Missouri," gives the following interesting account of the habits and earlier stages of this beautiful butterfly (pp. 144–8). "The species feeds upon most of the different kinds of milk-weed or silk-weed (*Asclepias*), and also upon dogbane (*Apocynum*), according to some authors. It shows a wonderful dislike, however, to the poke milk-weed (*Asclepias phytolaccoides*), and I was surprised to find that larvæ furnished with this plant would wander about their breeding-cages day after day, and would eventually die rather than touch it, though they would eagerly commence devouring the leaves of either *A. tuberosa*, *curassavica*, *cornuti*, or *purpurascens*, as soon as offered to them.

* Journal of Entomology, No. X., pp. 176–7 (1864).

† Whenever Fabricius was doubtful as to whether a species was obtained in North or South America, he seems to have put it down as South.

"The butterflies hibernate, though whether any but the impregnated females survive until the milk-weeds commence to grow, is not definitely ascertained. They commence depositing eggs in the latitude of St. Louis during the fore part of May. Some of the earliest developed butterflies from these eggs begin to appear about the middle of June, and others continue to appear for several weeks. These lay eggs again, and the butterflies abound a second time in October. Thus there are two broods each year, and though the first brood of larvæ are hatched more uniformly and within a more limited time than the second, the two broods yet connect by late individuals of the first and early individuals of the second, and the caterpillars may be found at almost any time from May to October, but are especially abundant during late summer and early fall.

"The egg is invariably deposited on the under side of a leaf, and is conical and delicately reticulate with longitudinal ribs, and fine transverse striæ. It is yellowish when first deposited, but becomes grey as the embryo within developes.

"In about five days after deposition the egg hatches, and the young larva as soon as hatched usually turns round and devours its egg-shell; a custom very prevalent with young caterpillars. At this stage it differs considerably from the mature larva; it is perfectly cylindrical, about 0·12 inch long and much of a thickness throughout. The head is jet-black and polished; the colour of the body is pale greenish-white, with the anterior and posterior horns showing as mere black conical points, and with two transverse-oval black warts, nearer together, on the first joint. It is covered with minute black bristles, arising from still more minute warts, six on the back, and placed four in a row on the anterior portion, and one each side on the posterior portion of each joint; and three on each side, one in the middle of the joint, and two which are substigmatal, posteriorly. There is a sub-triangular black spot on the anal flap, the legs are alternately black and white, and the stigmata are made plainly visible by a pale shade surrounding them.

"When the young worm is three or four days old, a dusky band appears across the middle of each joint, and by the fifth or sixth day it spins a carpet of silk upon the leaf, and prepares for its first moult. After the first moult the anterior horns are as long as the thoracic legs, the posterior ones being somewhat shorter; the characteristic black stripes show quite distinctly, but the white and yellow stripes more faintly. After this it undergoes but slight change in appearance, except that the colours become brighter and that at each successive moult the horns become relatively longer. There are but three moults, and the intervals between them are short, as the worms frequently acquire their full growth within three weeks from hatching.

"As soon as the larva is full grown it spins a little tuft of silk to the under side of whatever object it may be resting upon, and after entangling the hooks of its hind legs in this silk it lets go the hold of its other legs and hangs down, with the head and anterior joints of the body curved. In this position it hangs for about twenty-four hours, during which the fluids of the body naturally gravitate towards the upturned joints, until the latter become so swollen that at last, by a little effort on the part of the larva, the skin bursts along the back behind the head. Through the rent thus made the anterior portion of the pupa is protruded, and by constant stretching and contracting the larval skin is slipped and crowded backwards until there is but a small shrivelled mass gathered around the tail. Now comes the critical period—the culminating point.

"The soft and supple chrysalis, yet showing the elongate larval form with distinct traces of its prolegs, hangs heavily from the shrunken skin. From this skin it is to be extricated and firmly attached to the silk outside. It has neither legs nor arms, and we should suppose that it would inevitably fall while endeavouring to accomplish this object. But the task is performed with the utmost surety, though appearing so perilous to us. The supple and contractile joints of the abdomen are made to subserve the purpose of legs, and by suddenly grasping the shrunken larval skin between the folds of two of these joints as with a pair of pincers, the chrysalis disengages the tip of its body and hangs for a moment suspended. Then with a few earnest, vigorous, jerking movements it succeeds in sticking the horny point of its tail into the silk, and firmly fastening it by means of a rasp of minute claws with which that point is furnished. Sometimes severe effort is needed before the point is properly fastened, and the chrysalis frequently has to climb by stretching the two joints above those by which it is suspended, and clinging hold of the shrivelled skin further up. The moment the point is fastened the chrysalis commences, by a series of violent jerkings and whirlings, to dislodge the larval skin, after which it rests from its efforts and gradually contracts and hardens. The really active work lasts but a few minutes, and the insect rarely fails to go through with it successfully. The chrysalis is a beautiful object, and as it hangs pendent from some old fence-board or from the under side of an *Asclepias* leaf, it reminds one of some large ear-drop; but, though the jeweller could successfully imitate the form, he might well despair of ever producing the clear pale-green and the ivory-black and golden marks which so characterize it.

"This chrysalis state lasts but a short time, as is the case with all those which are known to suspend themselves nakedly by the tail. At the end of about the tenth day the dark colours of the future butterfly begin to show through the delicate and transparent skin, and suddenly this skin

bursts open near the head, and the new-born butterfly gradually extricates itself, and, stretching forth its legs and clambering on to some surrounding object, allows its moist, thickened, and contracted wings to hang listlessly from the body."

There has been much discussion as to how and when this *Danais* was introduced into the Australian region: the evidence seems to us to be in favour of its accidental introduction by man: * it has spread rapidly into most of the South Pacific Islands and is now gradually establishing itself in Papua; if its food-plants are to be obtained throughout the Moluccas and Malaysia, there seems to be no reason why it should not extend its range into India or even over the whole of the old world; oddly enough several examples have recently turned up in the British Isles.

Subfamily SATYRINÆ, *Bates*.

Percnodaimon, *Butler*.

2. *Percnodaimon pluto.*

Erebia pluto, Fereday.

Erebia merula, Hewitson, Ent. Mo. Mag., XII., p. 10 (1874).

Oreina (?) othello, Fereday, Trans. N.Z. Inst., VIII., pp. 302–4, pl. IX. (1876).

Percnodaimon pluto, Butler, Ent. Mo. Mag., XIII., p. 153 (1876).

Male.—Dark bronzy brown, slightly deeper in tint towards the outer margin; primaries with a paler subapical area, upon which are four white-pupilled large black ocelli; the first three coalescent, their pupils forming a triangle, the fourth immediately below them; wings below altogether paler and of a greyer tint, a fifth small ocellus on first median interspace of primaries; secondaries with the discal area irrorated with grey, so as to indicate a transverse irregular median line, and a rather wide outer border; body black; expanse of wings, 1 inch 11 lines.

Female.—Larger and altogether darker than the male, a minute additional subcostal ocellus in primaries; expanse of wings 2 inches 1 line.

Argyrophenga, *Doubleday*.

3. *Argyrophenga antipodum.*

Argyrophenga antipodum, Doubleday, Ann. and Mag. Nat. Hist., XVI., p. 307 (1845); Gen. Diurn. Lepid., pl. 63, fig. 6 (1851); Butler, Erebus and Terror, Lep., pl. 8, figs. 4–7 (1874).

Male.—Dark greyish-brown, paler at base; the disc of each wing covered by a large patch of fawn-colour, that of primaries enclosing a large rounded black subcostal bipupillated spot, that of secondaries crossed by three smaller unipupillated black spots; fringe of primaries tawny, of secondaries grey; body blackish; head, collar, and tegulæ clothed with testaceous

* See, however, Mr. W. L. Distant's paper, (Trans. Ent. Soc., London, 1877, p. 93, *et seq.*)

and grey hair; primaries below with the costal and basal areas greyish; discal area tawny, with sub-apical spot as above, bounded externally by a reddish-brown streak which becomes black at the external angle; costa and apical area sandy-yellowish; two subcostal internervular streaks and the outer margin shining silver; fringe ferruginous; secondaries sandy-yellow, the veins pale yellow; the whole of the internervular folds represented by well-defined shining silver streaks; a discoidal streak, and the outer margin also silver; costal margin white; fringe grey; body below grey, legs whitish; expanse of wings, 1 inch 11 lines.

Female.—Altogether paler, and smaller than the male, the borders above whitish; wings below whitish; the discal area orange, becoming very pale towards costa; markings as in the male, but less defined; expanse of wings, 1 inch 8–10 lines.

Subfamily, NYMPHALINÆ, *Bates.*

Pyrameis, *Hübner.*

4. *Pyrameis kershawii.* Pl. XII., Fig. 1.

Cynthia kershawii, M'Coy, Ann. and Mag. Nat. Hist., IV., vol. 1, p. 76 (1868).

Pyrameis cardui, var. *P. kershawii*, Butler, Erebus and Terror, Lep., p. 29 (1874).

Primaries above brown at the base; the central area fleshy-pink clouded with fulvous, crossed by an irregular oblique black belt, a spot of the latter divided off by a slender oblique line of the ground colour within the discoidal cell; apical area and outer border broadly black; a post-discoidal oblique trifid white patch, followed by an arched series of four white spots, the uppermost bifid, the lowermost largest and rounded; an indistinct sub-marginal series of linear white markings from above the second median branch to the costa; fringe white, interrupted by black at the terminations of the nervures; secondaries brown; the end of the cell and the disc flesh-colour, clouded with fulvous; the costa and apex black; four blue-centred discal black spots; a sub-marginal series of five fusiform black spots, end to end; a marginal series of larger sub-conical black spots; fringe as in primaries; body brown. Primaries below with the base to the middle of the cell rosy; the end of the cell white, bounded externally by a trifid black bar; the apical area varied with olive-brown and silvery-grey; the whole wing clearer and brighter than above; secondaries white, clouded with pale dull yellow and marbled with brown, indicating a central broad irregular band; the apical third of discoidal cell white; five discal ocelli; the second and fifth largest with bifid lilac centres, the first small with the iris broad and white internally, the third and fourth medium-sized with blue centres; outer border testaceous, edged with black, bounded internally by a sub-marginal white stripe, in front of which are two interrupted sinuated blackish lines filled in at anal angle with pale lilac; body below greyish-white; expanse of wings, 2 inches 6 lines.

5. *Pyrameis itea.*

Papilio (n.g.) itea, Fabricius, Syst. Ent., p. 498, n. 238 (1775); Donovan, Ins. New Holland, pl. 26, f. 1, (1805.)

Vanessa itea, Godart, Enc. Meth., IX., p. 321, n. 57 (1819); White in Taylor's New Zealand, pl. 2, figs. 2, 2 (1855).

Bassaris itea, Hübner, Samml. Esot., Schmett. (1816-24).

Pyrameis itea, Doubleday, Gen. Diurn. Lepid., p. 202 (1849).

Primaries above with the basal third golden-brown becoming tawny on its external margin, bounded by a broad oblique central yellow band crossed by the costal and median nervures and the first median branch, its inner edge limited internally within the cell by a transverse tapering black line; external area from the band to the outer margin black; a trifid yellow oblique spot beyond the cell; a bifid subcostal spot, and a spot above the third median branch, white; indications of two greyish lunulated sub-marginal lines; fringe between the veins white; secondaries bright chestnut-red, becoming golden-brown at the base and along the inner margin, the costal area, apex, and outer margin, black; four small rounded discal black spots, the two outermost pupilled with lilac; a lilac subanal streak, and behind it a longer streak of the ground-colour, both parallel to the outer margin; fringe as in primaries; abdominal area greyish-brown; body chiefly golden-brown; head and prothorax greyish; dorsum olivaceous.

Primaries below black, greyish at apex; sub-basal area bright chestnut-red, bounded by three black spots, two transverse and divergent within the cell, the third diffusely ovate below it; basal area dark grey, irrorated with sulphur-yellow within the cell; costal area on basal area black, crossed by numerous pale sulphur-yellow lines; central band sulphur-yellow, externally more angular than above; an annular blue marking at the end of the cell, followed by a sub-angulated tapering transverse pale yellow streak; two sub-apical white spots as above, and between them indications of two ocelli outlined in black, with reddish centres spotted with black; outer marginal border greyish, almost white on lower discoidal and second median interspaces, and intersected throughout by a blackish line; fringe as above; secondaries olive-brown, banded and spotted with black and dark brown, the markings in the cell and near the base outlined with whitish; the abdominal area and outer border irrorated with greyish and lilacine; five more or less complete discal ocelli, like those between the sub-apical spots of the primaries; body sordid whitish, the pectus clothed with dense coarse grey hair; expanse of wings, 2 inches 4 lines.

6. *Pyrameis gonerilla.*

Papilio (n.g.) gonerilla, Fabricius, Syst. Ent., p. 498, n. 237 (1775); Donovan, Ins. New Holland, pl. 25, fig. 2 (1805).

Vanessa gonerilla, White in Taylor's New Zealand, pl. 2, fig. 1 (1855).

Papilio generilla (sic), Fabricius, Mant. Ins., p. 44, n. 437 (1787).

Basal third of the wings above brown, external two-thirds blue-black; primaries crossed by a nearly central angulated oblique scarlet belt which does not reach the inner margin; a trifid transverse white spot beyond the end of the cell, followed by a series of six spots, the fifth large, the first, second, and fifth white internally, otherwise all blue; fringes greyish; secondaries with the whole centre of the disc scarlet, crossed by four oval blue-pupilled black spots in pairs, the inner pair nearest to the outer margin; body brown; abdomen pale at the sides.

Primaries below brown at base, apex, and outer border, the red belt of the upper side becoming white towards costa and yellow upon the costa, sharply cut, excavated in front, angulated from the second median branch, its lower extremity continued internally but abruptly interrupted by a rounded black spot below the first median branch; a large black patch over the end of the cell enclosing a violet annular marking followed by a whitish arched belt; the succeeding white spots as above but no blue spots; two indications of ocelli as in *P. itea;* a sub-marginal bluish-grey belt, bounded externally by a black streak from the lower radial to the external angle; secondaries olive-brown varied with darker brown, slaty-grey and whity-brown, and crossed by blackish lines indicating bands; abdominal and external areas irrorated with white; a discal lunulated lilacine line, bisinuated between each two nervures; five discal brown ocelli outlined with black, with reddish centres irrorated with lilacine, the two lowermost ones best defined; body below yellowish, the pectus clothed with dense woolly grey hair; expanse of wings 2 inches 8 lines.

Diadema, *Boisduval.*

7. *Diadema nerina.*

Female.—*Papilio nerina*, Fabricius, Syst. Ent., p. 509, n. 277 (1775); Donovan, Ins. New Holland, pl. 27, fig. 1 (1805).

Papilio iphigenia, Cramer, Pap. Exot., 1, pl. LXVII., figs. D, E, (1779).

Var. *Papilio proserpina*, Cramer, Pap. Exot., 3, pl. CCXVIII., figs. C, D, (1782).

Male?—*Papilio auge*, Cramer, Pap. Exot., 2, pl. CXC., figs. A, B, (1779).

Male.—Above black-brown, fringes white-varied; primaries with a large oval white-centred shining blue patch across the discoidal and third median veins; an oblique trifid sub-apical white spot; secondaries with a large central white-centred shining blue patch; body above blackish-brown, head and prothorax white-spotted; wings below red-brown, basal area of primaries ferruginous; basal half of costa black spotted with white; four black-edged sub-costal white spots; an oblique sub-apical white band; external angle broadly dark brown; a discal series of white spots and a double sub-marginal series of whitish spots; fringe white-varied; secondaries with the base of costa and anal area ferruginous; a diffused central transverse white

band; a discal series of white spots and a double series of lunated sub-marginal whitish spots; body below red-brown spotted with white, palpi and inner edge of femora white; expanse of wings, 3 inches 9 lines.

Female.—Above black-brown, fringes white-varied; primaries with a more or less extended tawny patch upon and above the internal border; an oblique whitish band beyond the cell, more or less divided into five elongated spots, the uppermost (upon the costal area) tinted with lilacine; a sub-apical whitish spot, from which a series of small rounded spots extends across the disc; a double sub-marginal series of interrupted lunulated whitish spots; secondaries crossed by a broad whitish patch bordered with tawny or pale blue; a sub-marginal series of spots as in the primaries; wings and body below much as in the male but redder, with the white markings better defined; expanse of wings, 3 inches 9 lines.

The range of this species is peculiar: it occurs in Java, Australia, New Guinea, and the Loyalty Islands. In Samoa a small representative occurs,* of which Mr. Whitmee has recently brought home a good series exhibiting scarcely any variation.

Dr. Semper, in his paper "Auf der Insel Yap gesammelte Schmetterlinge und deren Verwandlungsgeschichte," says that the larva is similarly marked in Yap, Ebon, and the Samoa Islands, lives long after it is adult, and then becomes a pupa very abruptly. The pupæ hang suspended everywhere on trees, old stones, etc., and change after twelve days. Breed in November. It is probable that the habits of the larva of typical *D. nerina* would be similar to that of Samoa.

Dr. Schmeltz, in his paper "Ueber Polynesische *Lepidoptera*," expresses the belief that the whole of the "species" *(Arten)* of this section of *Diadema* are varieties; his views respecting many of the forms recently characterized as species, show a similar tendency to lumping constant local forms which it is melancholy to contemplate; many of his conclusions respecting South Pacific species appear to be based upon an examination of series of allied forms from the Philippines.

Family **Lycænidæ**, *Butler.*

This family is now separated into two subfamilies—the *Lycæninæ* and the *Theclinæ*, to the former of which the whole of the New Zealand forms are referable.

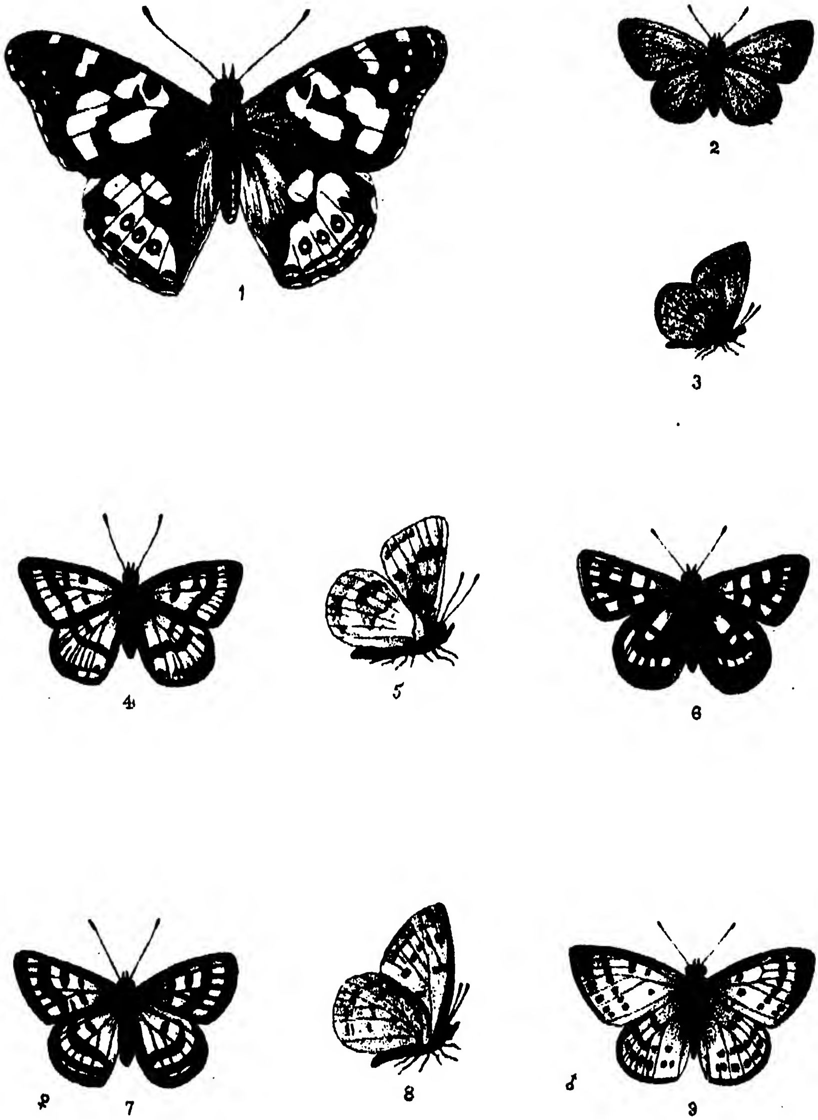
Subfamily Lycænidæ, *Stephens.*

Lycæna, *Fabricius.*

8. *Lycæna phœbe.* Pl. XII., figs. 2 and 3.

Lycæna phœbe, Murray, Ent. Mo. Mag., 1873, p. 107.

* *D. otaheitæ*, Felder.



To illustrate paper by A. G. Butler.

Male.—Wings above dull lilacine blue with a dull brown border, widest towards the apices of the wings; fringe and costal area of primaries, from the base to beyond the end of the cell, silvery-greyish; body brown, the thorax bluish-black; wings below pale greyish stone-colour; a discal series of whitish-bordered pale-brown spots, angulated upon the secondaries; a sub-marginal series of pale brown spots, lunulate on primaries and sagittate on secondaries, bounded internally by a white border, and enclosing an almost marginal series of triangular pale brown spots; a brown marginal line; fringes whitish; body below whitish; expanse of wings, 1 inch 2 lines.

This species seems to occur more or less commonly throughout Australia and the islands of the South Pacific; it is probably the male of *L. alsulus* of Herrich-Schäffer (described in the Stettin Zeitung for 1869), but this point requires confirmation.

9. *Lycæna oxleyi.*

Lycæna oxleyi, Felder, Reise der Novara, Lep., II., p. 280, pl. 35, fig. 6 (1865).

Male.—Wings above lilacine blue, rather brighter in tint than in the preceding species; primaries with the apex and outer border rather broadly shining dark brown; secondaries with the costal area broadly and the outer margin narrowly brown; fringes of all the wings white, spotted with brown at the terminations of the veins; body black, the head, tegulæ, and sides of thorax clothed with grey hairs; wings below greyish-brown; primaries glossy, irrorated towards the base of costal area with whitish scales; a black litura indicating the discocellulars, a discal oblique series of semi-circular black spots, angulated towards the costa; a double sub-marginal series of blackish spots, encircled by white scales; fringe as above; secondaries crossed by two irregular series of black spots, the inner series near the base composed of three or four small spots, the outer series angulated, very irregular, and composed of about eight larger spots; the whole basal area to the second series of spots irrorated with white scales; outer border irrorated with white with traces of sub-marginal spots; fringe as above; palpi, abdomen, and legs below white, pectus grey; expanse of wings 1 inch 1 line.

The measurements of this and the preceding species are taken from Mr. Enys' specimens.

Chrysophanus, *Hübner.*

10. *Chrysophanus boldenarum.*

Lycæna boldenarum, White, Proc. Ent. Soc., Ser. 3, 1, p. 26 (1862).

Chrysophanus boldenarum, Butler, Zool. Erebus and Terror, Ins. Lep., p. 29, n. 8; pl. 8, figs. 8, 9 (1874).

Male.—Wings above brown, shot with glistening purple; a curved discal series of six orange spots bordered internally with black on each wing; a

second ill-defined sub-marginal series not reaching the apices; outer margin broadly dark brown; primaries with a black spot towards the end of the discoidal cell and a second at the end of the cell; between and beyond these three or four ill-defined orange spots; secondaries with a black spot at the end of the cell, bordered internally with orange more or less distinctly; beyond it a series of more or less defined black spots, bordered externally with orange; body above blackish, crest grey; palpi white; wings below altogether paler; primaries pale tawny, the borders grey; two spots in the cell (the inner one sometimes obsolete), one at the end of the cell, and a curved discal series, black, indistinctly white-edged; a sub-marginal ill-defined series of greyish ocelloid spots; secondaries pale testaceous, a broad band across the centre of the wings, two sub-basal discoidal spots and a sub-marginal series silver-grey, white-edged; body below white; expanse of wings 10 lines.

Female.—Wings above without the purple shot, excepting a more or less strongly-defined sub-marginal line of spots; orange spots larger, sometimes paler, and covering the whole basal area of the wings; body as in the male; expanse of wings 1 inch 1 line.

This species seems to vary a good deal, more especially in the female sex.

11. *Chrysophanus salustius*, Fab.

Male.—Wings above bright shining fulvous; veins and margins black; base irrorated with olivaceous; discocellulars, a discal series of spots, and a sub-marginal series, black; primaries with a small spot in the cell, and usually a second below it, black; inner or abdominal area of secondaries and body olivaceous; thorax blackish; primaries below pale tawny, with the costal and external borders generally sulphur-yellow, sometimes greyish; inner border whitish or greyish; interno-median area greyish towards the base; sub-marginal black spots obsolescent; remaining black spots considerably larger than above; secondaries sulphur-yellow or sordid stramineous; the spots arranged as above, but greyish instead of black; body below sulphur-yellow; expanse of wings 1 inch 4–5 lines.

Female.—Generally paler than the male, the basal area dusky; the black spots above united into bands, below with the ground-colour paler than in the male, the spots usually smaller; expanse of wings 1 inch 8 lines.

12. *Chrysophanus enysii.* Pl. XII, figs. 4, 5, 6.

Chrysophanus enysii, Butler, Ent. Mo. Mag., XIII, p. 153 (1876).

Male.—Above very like *C. salustius.* *Female.*—Wings bright fulvous; veins black; a rather broad dark brown external border; an equally broad transverse sigmoidal discal band; base densely irrorated with black; primaries with a small round spot in the cell, a similar interno-

median spot, and an oblong discocellular spot, black; secondaries with a dark brown discocellular spot; several fulvous spots on the external border near the anal angle; wings below much paler; primaries deep ochreous; costal area dull sulphur-yellow; outer border brownish, paler towards apex, bordered within, towards the external angle, by black spots; discal band replaced by a row of blackish spots; basal spots smaller and narrower than above; secondaries stramineous, changing towards the base to sulphur-yellow; outer border pale clay-brown; an irregular narrow discal band, a sub-costal spot, the discocellulars, and a spot on the interno-median area, all pale clay-brown; body above olivaceous, the prothorax slightly fulvous; head blackish, with the margins of the eyes and sides of the palpi white; body below whitish; expanse of wings 1 inch 8 lines.

Female.—Considerably darker, the intervals between the bands reduced to golden-orange spots, the bands and veins being deep chocolate-brown; basal scaling more golden; wings below brighter, the secondaries crossed by a broad, sharply-elbowed reddish-brown band, which tapers to the abdominal margin; an ill-defined series of conical sub-marginal spots, of the same colour, with pale lilacine centres; body above much brighter than in the male; below tinted with rosy; expanse of wings 1 inch 8½ lines.

Male and Female, North Island.

13. *Chrysophanus feredayi*, Pl. XII, figs. 7, 8, 9.

Chrysophanus feredayi, Bates, Ent. Mo. Mag., IV., p. 53 (1867.)

Extremely like *C. salustius* above, but with the black spots of the male and the bands of the female usually rather broader; below with the outer border of the primaries and the whole ground-colour of the secondaries brown, the black spots rather smaller; expanse of wings, 1 inch 4 lines.

Family **Papilionidæ**, *Leach.*

Subfamily PIERINÆ, *Swainson.*

Catopsilia, *Hübner.*

14. *Catopsilia catilla.*

Female.—*Papilio catilla*, Cramer, Pap. Exot., 3, pl. 229, figs. D, E, (1781).

Male *and* **Female.**—*Callidryas catilla*, Butler, Lep. Exot., p. 24, pl. IX, figs. 7–10, (1869); Monogr. Callid., p. 3, n. 3, pl. 1, figs. 7–10 (1873).

Male.—*Papilio hilaria*, Cramer, Pap. Exot., 4, pl. 339, figs. A, B, (1782).

Male.—*Papilio titania*, Fabricius, Ent. Syst. Suppl., p. 28 (1798).

Var. *Callidryas phlegeus*, Wallace, Trans. Ent. Soc. London, 4, 3rd Ser., part 3, p. 401 (1867).

Sub-sp., Female.—*Papilio pomona*, Fabricius, Ent. Syst., 3, p. 213, n. 665 (1793).

Male.—Above with basal area sulphur-yellow; the external area white and slightly thickened; the apex, and sometimes two or three spots terminating the nervures towards the apex, black-brown; below whitish-sericeous,

with rosy outer margin; the primaries with silver-centred rosy discocellular spot, and three or four obliquely-placed strioles between the median and discoidal branches; secondaries with two connected silver-centred rosy spots at the end of the cell, and six to seven discal lunules forming an arc round them; expanse of wings, 3 inches 1 line.

Female.—Above typically bright sulphur-yellow, sometimes (and generally in the Australian region) pale sulphur-yellow, almost white; the primaries with a broad dentated, sometimes interrupted, marginal border; a more or less defined waved striolate discal band and discocellular spot, all blackish; secondaries usually with orange-tinted external border, the veins terminating in blackish dots; below golden-yellow, the outer border slightly deeper coloured, a rusty irregular patch (sometimes obsolete) terminating the cells of both wings and enclosing two connected silver-centred ocelloid spots; primaries with a rust-reddish discal interrupted angulated band; secondaries with three black-centred orange lunules on the median and interno-median interspaces; expanse of wings, 3 inches 2 lines.

Although this species ranges from Silhet to Queensland, but little is known of its habits. Captain Lang states that it frequents *Cathartocarpus fistula.*

Doubtful Species.

Subfamily Danainæ.

Hamadryas, *Boisduval.*

15. *Hamadryas zoilus.*

Papilio zoilus, Fabricius, Syst. Ent., p. 480, n. 163 (1775).

"Alis integerrimis, atris; anticis maculis tribus, porticis disco, albis; habitat in Novâ Hollandiâ."—*Fabricius.*

The wings are black, becoming brown towards the base; the primaries have three sordid whitish spots, and the secondaries have the whole central area of the wings white.

We have never seen an example of this species from New Zealand, but in Dieffenbach it is noted as belonging to the Lepidopterous fauna: as the species seems to frequent gloomy brushwood, it may have been overlooked by recent explorers.

Art. XXXVI.—*Notes on the Metamorphosis and Development of one of our large Butterflies* (Danais berenice), *or a closely-allied Species.*

By W. Colenso, F.L.S.

[*Read before the Hawke Bay Philosophical Institute, 13th August, 1877.*]

On the 25th January, 1875, Mr. Huntley, of Meeanee (a member of this society), sent me some insect larvæ, apparently of a butterfly, in a box. In

the letter which accompanied them, Mr. Huntley says:—"I send you some caterpillars gathered from 'cotton plants' in a neighbouring garden, grown from seed sown about two years ago. My attention was first drawn to them yesterday by a lady in the garden, she having gathered at least forty of them on her cherished row of 'cotton plants.' The most extraordinary thing seems to be that, although they made a large quantity of vegetable *débris* (more than a silk-worm), the leaves of the 'cotton plants' show no signs of having been eaten; and, further, there is nothing in the neighbourhood of the said plants upon which the caterpillars could possibly feed. These I send you I gathered myself from the plants—breaking off the twigs on which the caterpillars were clinging without disturbing them. I send also with them the important parts of the plant from which they were gathered. I shall be glad to know whether the caterpillars will eat what is in the box."

Unfortunately, when I received the box on the following day, the 26th, there was scarcely a vestige of vegetable matter remaining in it, save the woody fibrous parts of the small branches or twigs, and the ends (petioles) of a few hard leaf stalks, with a very small bit of a green capsule having the remains of soft spines, somewhat resembling that of a young one of *Datura stramonium;* and also a large amount of "vegetable *débris*" (fæces). Of the four larvæ, however, three were alive and very active, apparently ravenously hungry. I immediately procured them leaves of various plants, both indigenous and exotic—*viz.*, sow thistle *(Sonchus oleraceus)*, ngaio *(Myoporum lætum)*, Cape gooseberry *(Physalis)*, *Arthropodium cirrhatum*, *Dodonæa viscosa*, *Entelea arborescens*, *Coprosma lucida*, *Veronica* (species), *Acacia* (species), *Geranium*, roses, laurustinus, laburnum, flowering currant, *Cordyline*, and of clovers and grasses; but nothing I offered suited them—they would not eat.

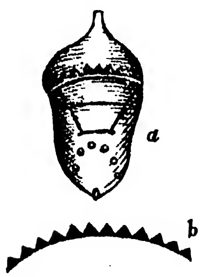
These larvæ appeared to be of gregarious habit; two of them were much larger than their companion, the third, being about two inches long, and of pretty uniform thickness throughout, each having six fore-legs (veræ) and eight hind ones; the body smooth, transversely and alternately striped or banded with bright yellow lilac and white, each having in all eleven yellow stripes, while on each side of the yellow stripe was (1) white, (2) narrow lilac line, (3) white, (4) broad lilac band nearly a line in width, (5) white, (6) narrow lilac line, (7) white, (8) yellow; so that between each of the eleven yellow transverse bands, were seven other bands and lines of lilac and white, which were clearly distinguishable when the animal stretched itself out in crawling; the feet and belly of the larvæ were of a dark-blue almost a blue-blackish colour; the head was regularly striped across with lilac and white; it had two antennæ or horns near its anterior end, which were also bluish-black and nine lines long, cylindrical, soft and flexible; it

had also two spinous processes near its tail, which were three lines long and soft. The larvæ were all very active, and kept incessantly moving their long flexible antennæ, or feelers, in all directions; in this respect more resembling those of a wasp or hornet, or some irascible perfect insect.

On the 27th January, the biggest larva (No. 1) commenced spinning a kind of fine web, by which it suspended itself by the tail only, and with no silky band around its body, in a box with a glass top, in which I kept them. The second large one (No. 2) did the same on the following day, January 28th, while the small one (No. 3), which I saw was not fully matured (and was apparently passing an uncomfortable kind of life, through its not having any proper food), did not enter into its pupa state until the 31st of January, or early on the 1st of February.

No. 1 emerged from its pupa state on the 15th of February; No. 2 on February 16th; and No. 3 on February 18th, being also imperfectly developed and of smaller size; so that 19–20 days is the time taken for its transformation, from its entering into the pupa state and its emerging a perfect insect.

The pupa was an elegant object, being 10–11 lines long and 6 lines wide (at its widest part), smooth, and of a pale pea-green colour, somewhat resembling in outline a small acorn in its cup, the stem of the cup (or calyx) being the produced point and the web by which it was suspended. Around the lower part of the pupa (as hanging) was a row of small circular dots, of a pale gold colour, having a metallic glistening appearance; while around the pupa in its widest part, and standing out a little from it, was a ridged crest or band, porcated towards the edge, which was crenulated; this, above, had also that metallic glistening appearance, while underneath, and seen from below, it was intensely black.



The accompanying wood-cut represents *(a)* the pupa, natural size, and *(b)* the ridged band, seen from below, magnified.

I have not unfrequently seen an ear-ring of greenstone worn by the Maoris of exactly the same hue of green as these pupæ.

But, if I was pleased with the elegant and unique appearance of the chrysalis, I was much more so with what I unexpectedly saw afterwards. I had watched them pretty narrowly, and when I found that No. 1 had quitted its pupa state on the 15th February, I watched No. 2 closely, and on the day after (the 16th) I was rewarded and gratified in seeing the perfect insect break forth into active life! I gazed with astonishment, and was almost spellbound—rivetted, as it were, for half-an-hour; and never have I seen a more interesting living gorgeous spectacle—one which I can never forget.

It broke through its pupa case at the top part, near the head and back of the imago, the case (in every instance) splitting longitudinally for two-thirds of its length into three segments, and then the insect moved its legs a little and got out of its prison, and held fast. At this time it appeared almost wingless, or with two tiny transversely-folded, squeezed-up plaits (like pigmy epaulettes) on its shoulders. These soon began to move, to descend, growing larger, and progressing downwards in an astonishing manner—soft, damp, limp, and wavy, their colours prismatically glistening like silk velvet, and at first falling in graceful folds, plaits, and rumples, without the least approach to stiffness. As its wings were mysteriously and silently evolved and produced, and grew and descended, they also widened to their natural size, but not at first.

It seemed a truly mysterious sight to see those large wings growing so fast—evolving from nothing! by some occult hidden power. It was not, for instance, like water (a spring) welling forth from a mountain's side over green moss, for there was the hidden quantity or mass—here there was nothing behind, and yet it evolved and grew!

It took forty-five minutes, or very nearly an hour, before its wings attained to their full size, after which they very soon stiffened, and became rigid. Beautiful they still were in their symmetry, colours, and markings; but, *sic transit!* the surpassing glory—that gorgeous pristine excellence which had so spell-bound me, was, as an object, gone for ever—never, however, to be forgotten while memory remains.

I have seen, at various times, many plants and flowers unfolding, opening, bursting forth into bloom and beauty—have watched the evolution of some of our elegant tiny ferns, the rapid growth and change of some fungi, and the wonderful and beautiful birth of the ephemeral day-lily, when it unrolls its gorgeous petals to the morning sun; but all that I have seen of that description pales and fades before this—the birth, the amazingly rapid growth, and the beautiful and mysterious development of this butterfly. Words fail to describe it, in its splendid and wonderful living reality—

"A thing of beauty is a joy for ever."

About four years ago, I heard from one of our members (Mr. Meinertzhagen) that he had captured at Waimarama a butterfly of this species. On his communicating with me concerning it, I identified it as one I had more than once seen in my travels in New Zealand many years before. Shortly after that I saw a pair of them flying here on the hill-side, at Napier; other specimens were also caught much about the same time, one, or more, of which are now in the Museum of the Athenæum in this town. And Mr. Meinertzhagen, and subsequently Mr. Huntley, found from the Maoris that they knew the insect well.

Mr. R. W. Fereday, of Canterbury, has a paper on the Waimarama butterfly, in Vol. VI. of the "Transactions of the N.Z. Institute." In that paper Mr. Fereday mentions two species (or varieties) *D. erippus* and *D. archippus*, specimens of both being in the Canterbury Museum. The former, *D. erippus*, having been sent from Melbourne; the latter, *D. archippus*, from San Francisco. Mr. Fereday doubts our New Zealand butterfly being distinct from *D. erippus*; at the same time he prefers giving it the specific name of *berenice*—which has superseded that of *erippus* in some published catalogues.

Mr. Fereday further says, that Mr. Nairn, of Poureerere, had found some larvæ of this insect on plants of *Gomphocarpus ovata* growing in his garden. It is not at all unlikely that the "cotton plants," whence Mr. Huntley obtained his specimens, were a species of *Gomphocarpus*, from the scrap of a spinous capsule, or follicle, I found remaining in the box; but the leaves were long and lanceolate, as I subsequently found from Mr. Huntley. I know several species of *Gomphocarpus*, but none bearing the specific name of *ovata*.

From a portion of a newspaper lately received from a friend, I find that our butterfly, or a species very nearly allied to it, was represented, in two very fair characteristic cuts, in the "Australian Sketcher," of July 12, 1878, under the name of *Danais archippus*, on the authority of Professor McCoy of Melbourne, where it had been lately captured, who says it is found very commonly in America from Canada to Brazil; but only of late years observed in North Australia, Queensland, and the northern parts of New South Wales, and more recently in Melbourne.

I venture, however, to doubt our insect being identical with the Australian one, as therein represented and described; there seems a slight difference in its markings, and a still greater one in its colour. Those differences, however, may be only sexual ones. Should it hereafter prove, on full examination and comparison of specimens of both sexes, to be distinct from both the Australian and American insects, I trust it will have, and retain, the name of *Danais novæ-zealandiæ*.

ART. XXXVII.—*On a new Species of Trapdoor Spider from New Zealand.* By the Rev. O. P. CAMBRIDGE, A.M., C.M.Z.S., Hon. Member N.Z. Inst. Plate X.

[*Read before the Otago Institute, 9th October,* 1877.]

IN the year 1874 I received from Capt. Hutton an adult female example of* *Nemesia* (found at Oamaru), but upon which, owing to its damaged condition, no reliable opinion could be formed. In the following year Capt. Hutton again forwarded me several females of the same species, from the same locality, with some particulars respecting their habits and nests observed by Mr. R. Gillies, and the welcome information that that gentleman purposed to record his numerous observations in a paper to be read before the Otago Institute. These specimens were also much damaged before they reached me, but, so far as they afforded means of determination, I was at first inclined to think that they comprised two very nearly allied, but probably distinct, species. In another bottle of various spiders, received at the same time and from the same locality, there was an *adult male* example (in excellent condition) of a *Nemesia*, which I have but little doubt is the male sex of the species to which the females that accompanied it belong. More recently still, Capt. Hutton has kindly sent me eight or nine adult females and numerous immature ones (mostly in good condition), upon the several nests of which Mr. Gillies' long and interesting paper has been published.† I have come to the conclusion, after long and repeated examinations and comparisons with each other, that, in spite of a considerable difference in size, all these examples (received at the various times mentioned above) belong to one and the same species, upon which I beg to confer the name of its discoverer, and to call it *Nemesia gilliesii.*

From Mr. Gillies' paper (l.c., p. 225) I understand that the nest—No. 1, pl. viii. (l.c.)—is supposed to have belonged to one of the female examples first sent to me by Capt. Hutton. This nest is of a decidedly different type from all the rest, having a branch issuing from near the middle, and furnished not only with a door to the main tube, but with an inner door or valve at the entrance to the branch. All the other nests are, although slightly varied in some characters, of *one type*, consisting of a

* The spiders referred to in this paper are very nearly allied to, and perhaps identical with, the genus *Pholeuon* (L. Koch. Die Arachniden Australiens, p. 471, pl. xxxvi., fig. 8, changed to *Arbanitis*, l. c., p. 491). The distinction, however, from *Nemesia* consists chiefly, if not wholly, in the denticulation of the tarsal claws, and seems scarcely important enough to require the formation of a distinct genus; especially as in the present species (which is quite a different one from that described by Dr. Koch) the denticulation of the tarsal claws of the female differs from that of the male.

† "Trans. N.Z. Inst," VIII., pp. 222–262, pl. vi.-viii.

single tube with an outer door (of the wafer kind). One nest (fig. 6, pl. viii.), indeed, has a branch, but there is no inner door connected with it; and from its position and character I feel little doubt that, at first, it formed part of the main tube, but owing to some cause or other—perhaps from filling or choking up—it became useless, and then the spider continued its nest in another direction. I have had an instance of this, not long since, in a tube of *Atypus sulzeri*, Bl., found in the Isle of Wight, and, more recently still, in several found at Bloxworth, and also others from Hampstead near London.

It appears that the only example of the *double-door branched type* of nest observed in New Zealand was not found by Mr. Gillies himself,* but by one of his servants. I am, therefore, inclined to believe that there has been a mistake in regard to its having been the nest belonging to one of the female spiders sent to me by Captain Hutton; for all of these spiders are certainly identical with those found in nests of the other type identified by Mr. Gillies himself, and received since from Captain Hutton. In absence of the clearest proof to the contrary, I take it that the different types of nest furnish decided characters of conclusive specific value. This, at least, is the result of the long and careful observations made in the south of France by the late Mr. Moggridge, all of whose materials, both spiders and nests, are in my possession, and have been the subject of repeated consideration and examination.

From Mr. Gillies' remarks (l.c., p. 226), he does not appear to have seen any nest with a true *cork-door*. All those found in New Zealand, as yet, are evidently of the *wafer-lid* kind; lids of this kind vary a good deal in their thickness, but cannot be mistaken for a moment for the true cork-lid, which fits *into* the opening of the tube as into a socket; while the wafer-lid shuts upon or *over* the opening; although in some species there is a portion of the middle of the lid which may enter slightly into the orifice.

With regard to the *enlargements* in the nest, I do not think this of specific

* There seems to be some little confusion, however, here in Mr. Gillies' paper. Compare p. 225, lines 3-9, from top of page, with p. 227, lines 4-7, and p. 260, lines 5-10.

From a letter received from Mr. Gillies since this paper was printed, I understand that the confusion alluded to was occasioned by the misprint (p. 227, line 6 from the top) of a figure 1 instead of 6. This does not, however, remove my conviction that I have not yet seen the spider by which the nest delineated in fig. 1, pl. viii, was constructed. Mr. Gillies tells me that some of the spiders captured by him were sent to Paris and others to Dr. Filhol; it is therefore possible that among these may have been the maker of the nest alluded to, as well as the example with a "peculiarly large and broad cephalo-thorax." See Mr. Gillies' paper, p. 225, and my observation on it, *postea p.* 283.

value; the same peculiarity is observable in nests of *Atypus*. Mr. Gillies has probably found out their true significance—that is, as receptacles for the egg cocoons. Perhaps the swelling of the egg cocoon, as the eggs advanced towards maturity, may, in some instances, have tended to increase the enlargement.

In making these observations on the nests of New Zealand trapdoor spiders, I have not had any examples of the nests before me; but from Mr. Gillies' paper, I conclude that he has had evidence of one nest only (pl. viii., fig. 1) of the *double-door branched* wafer-lid type, all the rest being *single-door unbranched* wafer-lid nests; the latter, however, presenting some small variations in curvature, and in the enlargement of a portion to receive the egg cocoon. All the spiders received by myself, I conclude, from their structural and special characters, to be, as before observed, of one species only, which varies chiefly in size; the varieties of depth, continuity, and confluence of markings not being of specific value. The real maker of the nest (fig. 1, pl. viii.,) I conclude, therefore, to be yet undetermined. This is a point for future research, and upon which I think Mr. Gillies may be able to find further evidence.

Should Mr. Gillies kindly honour me with any more materials, I would ask for the nests, and the spiders found in them, to be in every instance carefully labelled and kept separate from all others.* It is most probable that there are several species of trapdoor spiders in New Zealand. Mr. Gillies speaks of one with a "peculiarly large and broad cephalo-thorax" (l. c., p. 225). No such example was contained among those sent to me; but this character (unless produced by an accidental crush) would certainly be of specific value, in spite of the most exact similarity of the nest to that of others; for at present I take it, that although a *different type of nest* is conclusively specific in its value, yet all nests of exactly the same type are not necessarily so, since spiders of even different genera (*Cteniza* and *Nemesia*) form nests of the same type—viz., *unbranched single-door cork-lid*, and to these, I believe, I may add a species of another genus *Idiops* (*I. syriacus*, Cambr.) as also a fabricator of a nest of this type.

The strongest differential specific characters among the *Araneidea* are usually shown in the adult male; this sex should, therefore, be carefully sought. So far as I am aware, the males of trapdoor spiders are not

* The spiders last sent to me by Capt. Hutton were indeed carefully separated and labelled, with notes on the labels, referring to the numbers of the nests in Mr. Gillies' paper; but owing to the fracture of several of the larger bottles, the whole package was so soaked in spirit, that some of the labels had come off, and the writing on others was quite illegible. A single *number* written on a small piece of parchment, and placed *inside the tube* with the specimen, is the best mode of distinction; any notes can then be made by letter, and should be numbered to correspond with the parchment number in the tube.

always found in a tubular nest, but frequently in holes, crevices of banks, walls, mounds of rubbish and stones, as well as under logs of wood, and beneath loose bark, sometimes also in dark out-buildings, and often wandering about at night.

The following is a detailed description of one of the spiders last received from Captain Hutton, and belonging to one (though, from the cause mentioned in a note to p. 283, it is uncertain to which) of the nests figured by Mr. Gillies. I have selected it out of the eight or nine examples received as a type of the species, from its medium size, as well as because in its colours and markings it is intermediate between the darkest and most confluently marked, and the lightest and least confluent specimens. To this description I have also added one of the male spider, which (as before observed) I consider to be that sex of the species to which the female spider described belongs; and I beg to return my best thanks both to Mr. Gillies and Capt. Hutton for their kindness in sending me the materials for these observations and descriptions.

[P.S.—A point is mentioned in Mr. Gillies's paper (pp. 251–253) upon which I have, as yet, made no remark, chiefly because it is at present to me, as it is also to him, quite inexplicable—I allude to the nests which have been found covered and hermetically sealed up on the outside with clay or soil, and yet with the spider alive inside. Subsequent observations made by Mr. Gillies confirm the fact of this extraordinary sealing-up, which he attributes to the male spider. But for Mr. Gillies having suspected and searched in vain for a second tube with another external opening, I should have suggested this as a solution of the mystery.]

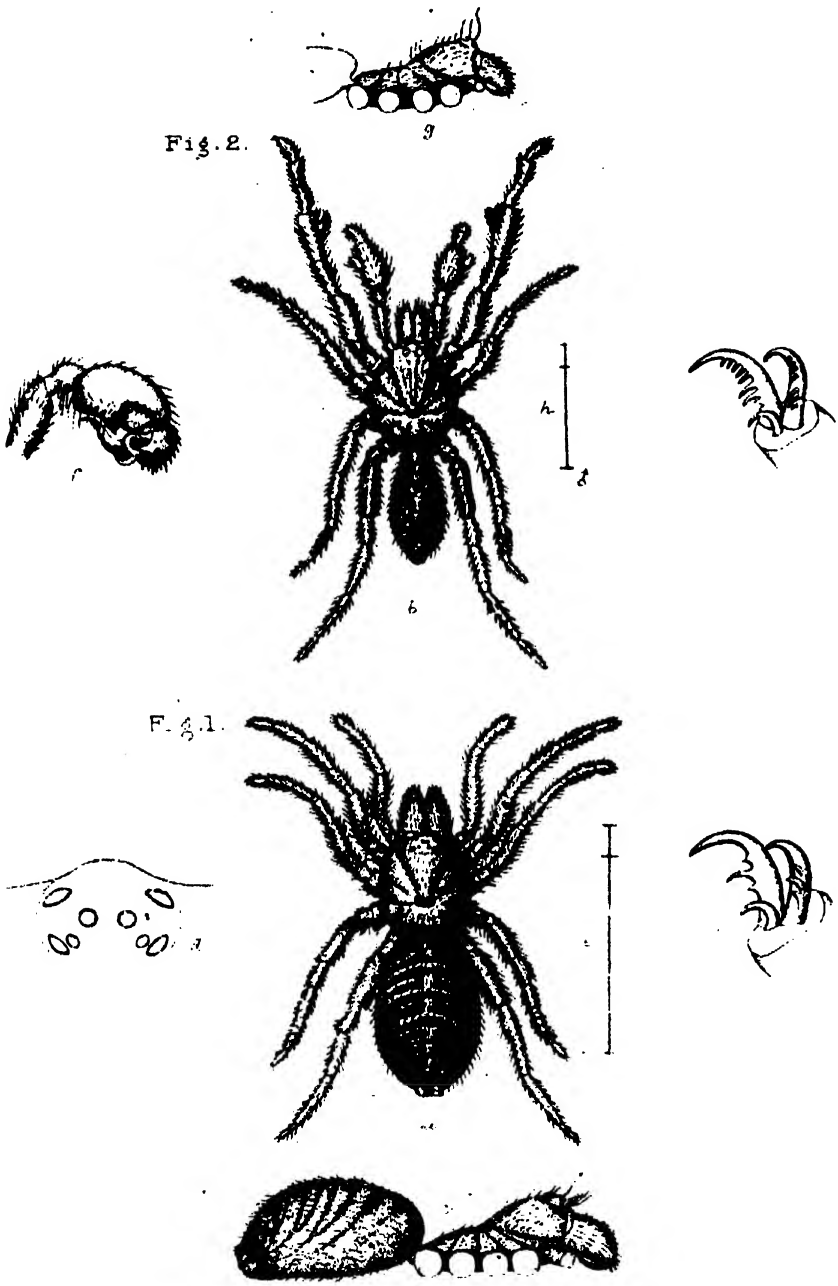
Family THERAPHOSIDES.

Genus *Nemesia*, Latr.

Nemesia gilliesii, sp. nov.

Adult Female.—Length, from 7 to 16 lines, exclusive of the falces. The length of the example described below is intermediate between these two extremes—12 lines. The cephalo-thorax is of an oblong oval form, truncated at each end, the fore extremity being rather broader than the hinder one. The thoracic portion is rather depressed, but the caput is elevated and tolerably well rounded above. The normal grooves and indentations are strong, especially the one which marks the junction of the caput and thorax. The ocular area is of a transverse oval form, slightly elevated and rounded; there are a few erect black bristles on this part, a single line of the same along the middle of the caput, and some stronger curved ones on the clypeus immediately in front of the ocular area; one in particular being much longer than the rest, more tapering, and somewhat sinuous.

The colour of the cephalo-thorax is dark yellow-brown, thickly clothed



NEMESIA GILLIESII (Cambr.)

with coarse adpressed dull sandy-grey pubescence, the ocular area being almost all black. The *eyes* are eight in number, seated on a slight oval eminence close to the fore extremity of the caput, and forming a transverse rectangular figure, whose longitudinal is rather less than half its transverse diameter. They are rather unequal in size. The four largest form the four corners of the quadrangle, those at its anterior corners being the larger; the two next in size are seated in a transverse line in the centre of the quadrangle; and close to the inner side of each posterior eye, but not quite contiguous to it, is another of a yellowish-white colour and flattened form, contrasting strongly with the dark hue of the rest.

The *legs* are strong, rather short, of a brownish-yellow colour, and furnished with hairs, bristles, and spines. The latter are most numerous, though shortest and most robust, on the metatarsi and tarsi of the third and fourth pairs—those on the third pair being on the upper and lower sides, while they are underneath only on the fourth pair; the spines on the first and second pairs are beneath the tibiæ and metatarsi, and are longer and less strong than those of the two hinder pairs. The genual joints of the third pair are furnished with short strong spines, but the number does not appear to be constant—varying from three to (in one example) eight, and sometimes differing, by one or so, on the opposite sides of the same spider; no example, however, out of twelve adults examined, is entirely without spines on this joint; the tibiæ also of the third pair have a single short strong spine on the outer sides. In one specimen, however, (that of which the genual joint had *eight* spines) the tibiæ had *two*, in another with seven on the genua, the tibiæ had *three*; and in another there were three on the genua with *two* on the tibiæ. The *tarsi* terminate with three strong, curved claws, those of the superior pair are the strongest, and are furnished, so far as I could ascertain, with three teeth on the under side of the hinder portion, near the middle; the central tooth being much longer and stronger than the one above and below it, but the denticulation of these claws seems to vary a little on the different legs. The tarsi and metatarsi of the first and second pairs are furnished beneath with a broad and compact scopula. The relative length of the legs is 4, 1, 2, 3. The *palpi* are short and strong, similar in colour to the legs, furnished with hairs and bristles, and a few long tapering spines beneath the radial joint; the digital joint has a broad compact scopula beneath its whole length, and terminates with a single strong curved denticulate claw.

The *falces* are strong and prominent, of a dark reddish yellow-brown deepening almost to black at the fore extremity; they are furnished with sandy-grey hairs mixed with strong dark hairs and bristles, and with a group of short strong spines on the upper side of their fore extremity.

The *maxillæ* are strong, slightly curved, divergent, and cylindrical in form, furnished with bristles and hairs, and a group of very short deep red-brown tooth-like spines at their hinder extremity, just above the labium.

The *labium* is short, convex in front, of an oval form, broadly truncated at its apex; it is of a red-brown colour, the apex being of a yellow hue.

The *sternum* is somewhat oblong, broader behind than in front; the fore extremity being deeply indented for the reception of the labium, and the hinder extremity obtusely pointed, the surface is strongly convex, hairy, and covered with very minute tubercular granulations.

The *abdomen* is large, hairy (the colour of the hairs being sandy-grey, mixed with others of a darker hue), of an oval form, very convex above, of a dull yellow colour, marked on the upper side with transverse curved black, more or less broken stripes, which run down over each side. These stripes are composed of more or less confluent black spots, and are, some of them, broken off in the middle, leaving an indistinct longitudinal central dull yellow band. On the fore half of the abdomen the stripes are more confluent than on the hinder half; the under side has an irregular strongly dentated black marking along the middle, but strongest and most distinct at its fore extremity. The spinners are four in number, short and strong; those of the superior pair are three-jointed and upturned; the basal joint being much the longest and strongest. The genital aperture consists merely of two strong transverse contiguous labia. In one or two examples, the under side of the abdomen is pretty thickly spotted with black, and there is some small variety in the extent and clearness of the transverse stripes in different examples. In very young specimens the stripes are simply rows of spots. Notwithstanding the great difference of size, I cannot find any other reliable specific variation in either of the twelve adults, and numerous immature examples, examined.

Adult male.—Length (exclusive of the falces) 6¼ lines; the only example examined of this sex is of a generally lighter and clearer yellow ground colour than the female, and the fore part of the caput is narrower, giving the cephalo-thorax a more regularly oval form; the normal grooves and furrows (especially those which mark the union of the caput and thorax) are strongly marked with reddish-brown; the caput also has two longitudinal, nearly parallel, brown lines, running from the eyes to the thoracic junction, where the other markings also converge, and give the cephalo-thorax a radiated appearance. The cephalo-thorax is clothed with dull, sandy-grey adpressed hairs, and there are some erect bristles on the caput similar to those of the female.

The relative size and position of the *eyes* is the same as in the female, although rather more closely grouped together.

The *legs* are longer, but their general armature is similar. The tarsal claws, however, are quite differently denticulated, four small teeth on the under side of the anterior half being followed by two much longer curved ones and another small one. The tibiæ of the first pair are also proportionately longer and stronger, and have near their fore extremity, on the inner side, two nearly black protuberances, of which the hinder one is much the largest and rather of a curved form; the extremities of these protuberances are slightly denticulated, and the metatarsi of the same pair of legs are curved in a sinuous form. The *palpi* are rather long, and the radial joint is abnormally large and tumid, being of a nearly oval form; rather underneath on the outer side is a strong ridge-like protuberance, armed with numerous short tooth-like black spines; and immediately in front of this is a corresponding depression, of which the upper edge is furnished with some very minute black denticular spines; the digital joint is not very large; its margins are dark red-brown and somewhat corneous, and its fore extremity is strongly emarginate, with a largish lobe on the inner side and some strongish spines and bristles. The palpal organs consist of a nearly globular but rather flattened corneous lobe prolonged into a long curved tapering process, whose extreme point is rather twisted but not very sharp. When at rest, this process extends backwards, reaching to about two-thirds of the length of the radial joint, the point however having a strong outward direction. The *abdomen* is small, of a narrow oval form, but strongly convex above; its markings are similar to those of the female, though the spots forming them are far less confluent, and therefore the abdomen has a more spotty appearance.

A single example of the male was received (with two females) from Captain Hutton, in 1875, in some bottles of various other spiders, labelled "Oamarŭ," and I feel no doubt but that it is of the same species as the two females mentioned.

DESCRIPTION OF PLATE X.

Fig. 1. *Nemesia gilliesii* (female): *a*, spider a little enlarged; *c*, ditto in profile; *d*, eyes from behind; *k*, extremity of tarsus of right leg of fourth pair of legs from outer side, showing tarsal claws; *l*, natural length of spider.

Fig. 2. *Nemesia gilliesii* (male): *b*, spider enlarged; *g*, cephalo-thorax and falces in profile; *f*, right palpus from outer side; *m*, extremity of tarsus of right leg of fourth pair of legs from outer side, showing the tarsal claws; *h*, natural length of spider.

Art. XXXVIII.—*Second Note on the Maori Rat.*
By Prof. F. W. Hutton.

[Read before the Otago Institute, 7th August, 1877.]

Last June the Museum received from Mr. Cocker a dried specimen of a rat found by him in a cave, along with some old Maori mats, etc., on Mount Benger. This specimen consists of the skeleton nearly complete, and the dried skin with a few hairs on it. A comparison of its skull with those from Shag Point, described in my former paper * left no doubt as to its being the true Maori rat, so that I am now able to add a little more to our knowledge of this animal. The following are the principal dimensions:—

	Inches.
Length of the skull	1·84
„ snout to root of tail	4.00 (about)
„ of tail	4·75 (perhaps rather more)
„ of hind foot	·87

There are thirty caudal vertebræ, but one or two at the end may be wanting. The hair on the belly is whitish, that on the back and sides mouse-grey, but all the colours may have been bleached. It will be seen that the measurements and colour correspond very well with a small specimen of the black rat *(Mus rattus.)*

Art. XXXIX.—*Notes on the New Zealand* Myriopoda *in the Otago Museum.*
By Prof. F. W. Hutton.
Plate XI.

[Read before the Otago Institute, 5th June, 1877.]

Cermatia smithii, Newport. Ann. Nat. Hist. XIII., p. 96.
Hab. Auckland.

Henicops impressus, sp. nov.

Head broadly ovate, narrowed towards the front, with an elevated margin behind, and an impressed curved transverse line, convex backward, on the top before the eyes; space between the antennæ concave. Dental lamina with eight acute teeth. Antennæ tomentose, with 34–36 joints. Segments 15 (without the head), alternately large and small; but the small segment between the 7th and 8th, and between the 14th and 15th, absent; each segment with a raised margin. Above olive-brown, generally more or less marbled with black; legs pale bluish; feet yellow. Under surface of

* "Trans. N.Z. Inst.," IX., p. 348.

head and region of anus reddish. Some scattered hairs on the legs. Length, ·6 inch.

Hab. Dunedin and Queenstown.

It is astonishing with what rapidity this creature runs.

Cormocephalus violaceus, Newport. Linn. Trans., XIX., p. 424.

Hab. Wellington.

I have not seen any species of *Cormocephalus* from the South Island.

Himantarium ferrugineus, sp. nov. Fig. 1.

Head sub-quadrate, longer than broad; anterior margin slightly convex, sides nearly straight, posterior margin straight. Antennæ approximated, moniliform, finely pubescent. Body composed of about 110 segments, which retain nearly the same breadth throughout. Basal article of the last pair of legs deeply and coarsely punctate, both above and below. Præ-anal scale rather attenuated behind, and with a straight margin. Entirely pale red; antennæ rather lighter. Legs smooth. Length, 4·3 inches. Breadth, ·1 inch.

Hab. Wellington and Inch Clutha.

One specimen has abnormal antennæ of only 12 joints, and the 10th and 11th joints are vasiform.

Himantarium morbosus, sp. nov. Fig. 2.

Head elongate, convex on the sides; anterior margin sinuated, posterior straight; its length equal to about twice its breadth. Antennæ approximated, moniliform, hairy. Body composed of about 40 segments. Basal article of the last pair of legs smooth above, punctured below. Præ-anal segment rather longer than broad. Præ-anal scale rounded. Pale reddish-yellow; head and antennæ ferruginous. Legs hairy. Length, 1·85 inch. Breadth, ·07 inch near the head, tapering posteriorly.

Hab. Wellington and Dunedin.

Iulus (Spirostreptus) antipodarum, Newport; Dieff. N.Z., II., p. 270. Fig. 3.

Head smooth, emarginate anteriorly, deeply excavated behind the antennæ. Antennæ of seven joints, the last very small, the third rather longer than the second, the 4th, 5th, and 6th subequal, vasiform, contracted at the base; all the joints from the 3rd tomentose. Eye-patch sub-elliptical, eyes in three rows of 8, 7, and 6 respectively. Segments 54. The first rounded in front, with the lateral points blunt. Latero-posterior portion of each segment with fine distant oblique striæ, which are more distinct on the anterior portion of the body than on the posterior, and are very indistinct in the young. Remainder of segments smooth, with a shallow pore at each side. Præ-anal segment rounded. Variable in colour

from pale to dark brown, with the segments sometimes uniform, sometimes darker in front. Legs yellowish. Length, 1·8 inch.

Hab. Wellington, Dunedin, Clyde, Preservation Inlet.

A very common species. When put into alcohol it stains it a dark purple.

Iulus (Spirostreptus) striatus, sp. nov.

Head smooth, emarginate anteriorly. Antennæ tomentose, 7-jointed, the 2nd the longest, the 3rd to the 6th sub-equal. Segments 47, the posterior half of each with fine distant longitudinal striæ on the dorsal and lateral surfaces; anterior portion smooth. Lateral margin of first segment rounded. Præ-anal segment terminating in a slightly obtuse rounded point, not passing the anal valves. Upper surface brown, paler below. Length, ·4 inch.

Hab. Dunedin.

Iulus berardi, Walck. (Gervais, Apteres, IV., p, 333), is a very different species, which I have never seen.

Polydesmus (Oxyurus) serratus, sp. nov.

Antennæ tomentose, 7-jointed; the 2nd and 3rd equal, and longer than the 4th and 5th, the 7th very small. Top of the head pentagonal; face with a few scattered hairs, smooth. Segments smooth, the sides of each produced into a strong keel, which extends backward on each side in an acute curved angle. Præ-anal segment terminating in a blunt point, with scattered white hairs; the inferior semicircular slightly toothed. Dirty white, with a more or less distinct brown dorsal stripe; under surface white. Length, ·4 inch.

Hab. Dunedin.

Polydesmus (Oxyurus) worthingtoni, sp. nov.

Antennæ tomentose, 7-jointed; the 2nd much longer than the 3rd or 4th, which are subequal. Segments 18 or 19, the same as in the last, but the angles on each side spring more suddenly from the posterior margin. Præ-anal plates as in the last. Dark reddish-brown. Length, ·65 inch.

Hab. Queenstown.

Named after Mr. J. S. Worthington, of Queenstown.

Polydesmus (Strongylosoma) gervaisii, Lucas, Hist. Anim. Artic., Apt., p. 525; Gervais, Apteres, IV., p. 118. Fig. 4.

Hab. Dunedin, Preservation Inlet.

New Zealand specimens agree so well with the description of this Australian and Tasmanian species, that I have no hesitation in considering it as the same. *P. novaræ*, Humbert and Sauttare (Verhandl. Zool. Bot. Gesellsch. in Wien, 1869, p. 689), is very closely allied, if not identical with

it. It is very common about Dunedin, where we find not only specimens resembling the type in colour, but also a variety of a pale rose-red, marbled with white, and with white legs. The specimens from Preservation Inlet are entirely blackish-brown.

The length is about an inch, and the number of segments is 19, not including the head and anus. It has 29 pairs of legs, the 2nd, 3rd, and 4th segments having only one pair. The 2nd and 3rd joints of the antennæ are equal and longer than the 4th, 5th, and 6th.

Polydesmus (Strongylosoma) macrocephala, sp. nov.

Antennæ 7-jointed, all finely pubescent; 4th and 5th the shortest. First segment smaller than the head; lateral margins rounded. Segments smooth, very slightly keeled on each side. Præ-anal segment terminating in a blunt point without any hairs; the inferior semi-circular with a longitudinal keel. White with pale brown spots and vermiculations. Length, ·6 inch.

Hab. Dunedin.

Craspedosoma trisetosa, sp. nov. Fig. 5.

Antennæ 7-jointed, reaching back to the 7th segment; the first and last joints short, the 3rd longest. Eye-patch pyriform; eyes in four rows, of 6, 6, 5, and 4 respectively. Segments 32, finely granulated on the back, and with a depressed longitudinal line down the centre; the lateral margins straight. Each segment with three long bristles on each side, springing from tubercles, of which the lowest is the largest, and the highest the smallest. Antennæ and legs with short hairs. Head yellowish, with a dark band between the antennæ. Eyes and antennæ dark brown. Segments blackish-brown, each with oblique bands of olive before and behind the setiferous papillæ. Legs pale yellow, marked with dark brown on the last two or three joints. Occasionally it is brown, marbled with olive. Length 1 inch.

Hab. Dunedin.

Sphærotherium leiosomus, sp. nov. Fig. 6.

Head sparingly, coarsely, irregularly punctured, with a deep central transverse depression at the posterior margin, and a few short bristles in front. Antennæ slightly setose, six-jointed; the last joint cylindrical, rounded at the tip. Nuchal plate smooth, but uneven, with a slight central depression in front, and an anterior marginal ridge. Dorsal plates covered with very fine shallow punctures. First dorsal segment with a distinct lateral marginal ridge. Last dorsal segment arched, slightly compressed, its margin entire and not ridged. Intermediate segments with the lateral extremities broad, rounded in front and rectangular behind; with a rough

triangular excavation at the anterior lateral angle. The tenth and eleventh segments broader than those before them. Black, shining, more or less marbled with dark testaceous. Length, ·75 inch. Breadth, ·4 inch. Width of head, ·2 inch. Depth of head ·12 inch.

Hab. Dunedin.

This species differs from *S. delacyi* (White, Ann. Nat. Hist., 3 Ser., III., p. 406), which I have not seen, in its colour, in not being attenuated posteriorly, and in the head being much broader and shorter. In other respects the two are very similar.

Appendix.

As Humbert and Saussure's paper, in which the Myriopoda taken from New Zealand by the Novara Expedition are described, is not very accessible in New Zealand, I subjoin their descriptions.

Polydesmus (Oxyurus) haastii.

Fusco-niger, corpore antico attenuato, plus minus granulato; carinis retrorsum uncinatis, poris lateralibus; dorso antice valde arcuato, dein minus convexo; metazonites sulco obsoleto partitis, pone sulcum serie transversa areolarum sex ornatis. Fem., long. 25 mill.; larg. 4 mill.

Hab. Auckland, Waikato River.

Polydesmus (Strongylosoma) novaræ.

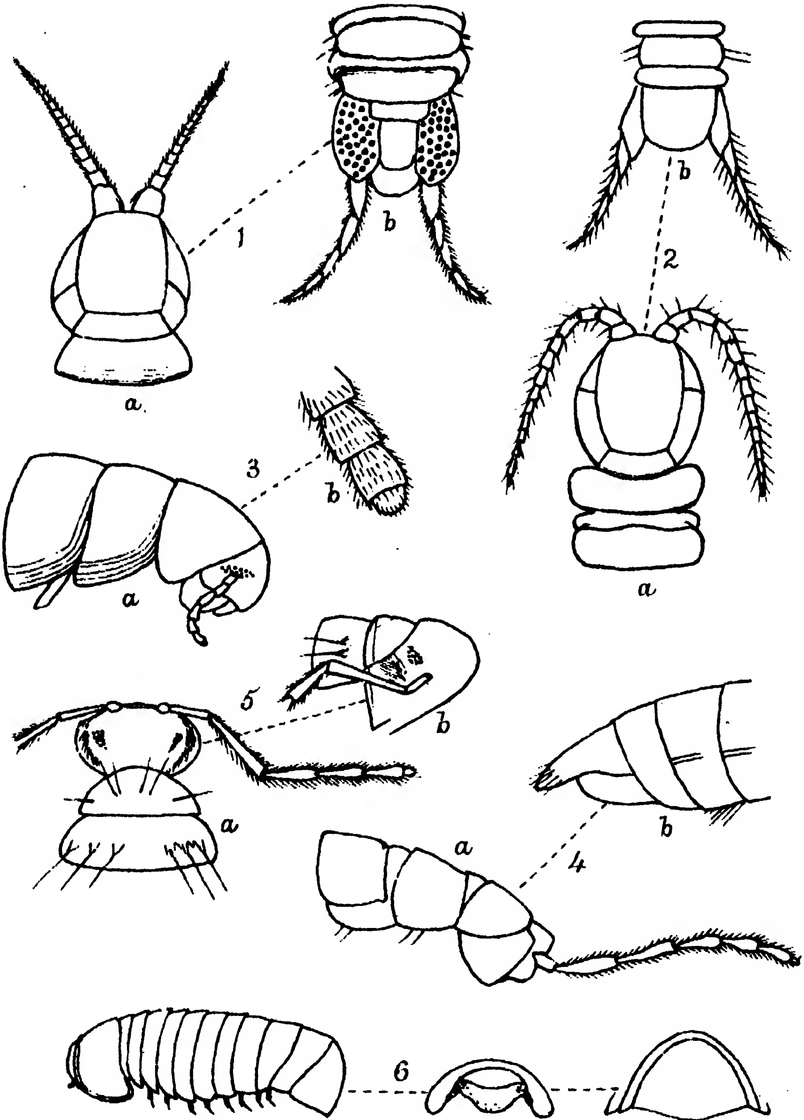
Fusco-castaneus, lævis, nitidus; carinis pedibusque flavidis; primo segmento antice valde arcuato, lobis lateralibus antice sulco marginali; segmento secundo cingulum efficiente, utrinque quadratim secto, margine reflexo, carinam elongatum linearem efficiente; carinis reliquis in media altitudine corporis sitis, crassiusculis, postice subangulatis, sed non productis; poris lateralibus; segmento præ-anali apice in processum lamellarem et obtusum producto; metazonites sulco profundo transversali partitis. Long., 18 mill.; larg., 2·5 mill.

Hab. Auckland.

Polydesmus (Icosidesmus) hochstetteri.

Albidus, depressus, nitidus; corpore antice et postice attenuato; antennis gracilibus, elongatis, articulis 2° et 3° longioribus; primo segmento semi-orbiculari, angulis rotundatis, segmentis 2–4 minutis, tertio minore; metazonites transversis, utrinque rotundatis, margine postico crasso, carinis parum prominulis; tuberis nullis; poris minimis, superis, marginalibus; segmento præ-anali minuto, trigonali, lamina præ-anali trapizina. Long., 20 mill; larg., 2·7 mill.

Hab. Auckland.



MYRIAPODA.

F. W. Hutton, del.

EXPLANATION OF PLATE XI.

Fig. 1. *Himantidium ferrugineus*	..	*a* anterior extremity *b* posterior extremity
„ 2. *Himantidium morbosus*	.. ..	*a* anterior extremity *b* posterior extremity
„ 3. *Iulus antipodarum*	.. ..	*a* profile of anterior end *b* extremity of antenna
„ 4. *Polydesmus gervaisii*	.. ..	*a* profile of anterior end *b* profile of posterior end
„ 5. *Craspedosoma trisetosa*	.. ..	*a* anterior end from above *b* profile of anterior end
„ 6. *Sphærotherium leiosomus*	.. .. ..	*a* profile *b* head, nuchal plate and first segment from the front *c* last two dorsal segments from behind.

ART. XL.—*Contributions to the Conchology of New Zealand.*

By Prof. F. W. HUTTON.

[*Read before the Otago Institute, 9th October,* 1877.]

Ianthina iricolor, Reeve ; Conch. Ic., fig. 23.

Specimens have been sent me from the North Island by Mr. T. Kirk.

Trophon dubius, Hutton ; Jour. de Conch., 1877.

Ovato-fusiform, thick ; whorls seven, convex, rudely spirally ribbed, those of the spire whorls transversely ribbed. Aperture oval ; canal very short, not bent, and rounded anteriorly. Covered with a greenish-brown persistent epidermis. Interior dark purple ; canal and anterior portion of columella whitish. L. ·7 ; B. ·4.

Hab. Auckland—Mr. T. F. Cheeseman.

Fusus spiralis, Adams ; P.Z.S.

F. pensum, Hutton ; Cat. Mar. Moll.

Fusus incisus, Gould.

Gould gives the habitat as uncertain, "probably New Zealand." I have seen no specimens.

"Shell of medium size and moderate thickness, of an elongated ovate form, of a cinereous brown colour, everywhere encircled with narrow, deeply impressed striæ of a more decided brown colour than the interspaces, about ten on the penultimate whorl. The apical whorls have also eight or nine longitudinal undulations. Whorls six or seven, convex, the last two-thirds the length of the shell, tapering about equally each way; siphonal beak short, a little recurved. Aperture one half the length of the shell, narrow, suboval; outer lip regularly arcuate, crenulated by the impressed lines,

and deeply sulcate within; pillar lip nearly straight, a little contorted, smooth, purplish-brown; whole interior livid brown; axis, 1¼ inch; breadth, ¾ inch" (Gould).

Neptunæa zealandicus, Quoy and Gaimard.

F. australis, Hutton; Cat. Mar. Moll. (not of Quoy).

Neptunæa caudata, Quoy and Gaimard.

F. mandarinus, Hutton; Cat. Mar. Moll.

Euthria martensianus, Hutton; Jour. de Conch., 1877.

F. littorinoides; Cat. Mar. Moll (not of Reeve.)

Drillia buchanani, Hutton; Cat. Tertiary Moll. of N.Z., p. 4.

Recent specimens have been sent from Auckland by Mr. T. F. Cheeseman.

Drillia cheesemani, Hutton; Jour. de Conch., 1877.

Ovato-fusiform. Spire acute, of nine whorls. Whorls rather angled, suture well marked. Spire whorls smooth in front, obliquely striated behind; body whorl equal to or rather longer than the spire; a smooth band at the sinus, behind which it is obliquely striated, and in front spirally ribbed; the interstices finely transversely striated. Nine or ten ribs on the outer lip in front of the smooth band. Canal very short. Pale brown. L. ·75.; B. ·35.

Hab. Auckland—Mr. T. F. Cheeseman.

This may be the same as *P. zealandica*, Smith (Ann. Nat. Hist., 1877, p. 492), in which case my name will have to give way to it.

Pleurotoma antipodum, Smith; Ann. Nat. Hist., 1877, p. 491.

I have seen no specimens.

Drillia maorum, Smith; Ann. Nat. Hist., 1877, p. 497.

I have seen no specimens.

Daphnella cancellata, Hutton; Jour. de Conch., 1877.

Fusiform, thin, finely cancellated; spire acute; aperture oblong, slightly channelled in front, and with a slight posterior sinus. Yellowish-white, slightly blotched with brown.

Hab. Auckland—Mr. T. F. Cheeseman. L. ·5.; B. ·2.

Polytropa retiaria, Hutton; Jour. de Conch., 1877.

Ovato-fusiform. Whorls keeled, spirally ribbed; four or five ribs on the body whorl in front of the keel, and one small rib behind it. Ribs crossed at regular intervals by transverse plications, dividing the surface of the shell into squares. The whole shell covered by delicate transverse foliations. Aperture oval; columella rounded. Canal short, slightly bent. Greyish-white; interior purple. L. ·9; B. ·5.

Hab. Auckland—Mr. T. F. Cheeseman.

Polytropa biconica, Hutton; Jour. de Conch., 1877.

Small, broadly fusiform. Spire short, acute. Body whorl inflated posteriorly, and narrowed anteriorly; spirally ribbed, and slightly transversely plicated. Whitish, tessellated with dark brown on the ribs; interior dark purplish-brown, toothed with white on the right lip. L. ·4; B. ·28.

Hab. North Island—Mr. T. Kirk.

Pyrene flexuosa, Hutton; Jour. de Conch., 1877.

Fusiform; spire acute, conical, as long as the aperture, smooth; whorls six. Inner lip smooth, outer striated internally, slightly thickened in the middle. White, with longitudinal flexuous streaks of pale brown. L. ·28; B. ·1.

Hab. Auckland—Mr. T. F. Cheeseman.

Lunatia australis, Hutton; Jour. de Conch., 1877.

Globose, smooth, whorls 3½; suture well marked, but not excavated; umbilicus rather narrow, without any groove. Inner lip with a callus. Brown or grèy. L. ·3; B. ·3.

Hab. Auckland—Mr. T. F. Cheeseman.

Philippia lutea, Lamarck.

Dead specimens have been collected at Matakana by Mr. Mathews.

Rissoa flamulata, Hutton; Jour. de Conch., 1877.

Smooth; red, generally with oblique white rays. Whorls, 6 or 6½. L. ·25.

Hab. Auckland—Mr. T. F. Cheeseman.

Trochita novæ-zealandiæ, Lesson; Voy. Coquille, II., p. 395.

T. maculata, Quoy and Gaimard.

Trochita scutum, Lesson; Voy. Coquille, II., p. 395.

T. tenuis, Gray.

Crypta monoxyla, Lesson; Voy. Coquille, II., p. 391.

C. contorta, Quoy and Gaimard.

Trochus (Polydonta) acinosus, Gould.

This is the same as *P. tuberculata*, Gray.

Clanculus variegatus, Adams.

I have received a single dead specimen from Auckland.

Euchelus bellus, Hutton.

I have a reddish-brown variety from Auckland, collected by Mr. T. F. Cheeseman.

Diloma corrosa, Adams; P.Z.S.

I have specimens from Dunedin.

Trochocolea constricta, Lamarck.

I have specimens from Auckland, sent by Mr. T. F. Cheeseman.

Trochocolea mimetica, Hutton; Jour. de Conch., 1877.

Perforated. Inner lip thin, slightly expanded over the always open umbilicus. Purple, with oblique, slightly waved white lines. Columella more or less stained with green. L. ·5; B. ·6.

Hab. Auckland—Mr. T. F. Cheeseman.

Gibbula plumbea, Hutton; Jour. de Conch., 1877.

G. nitida, Cat. Mar. Moll; not of Adams, which is *Chrysostoma inconspicua* of the Cat. Mar. Mollusca.

Gibbula oppressa, Hutton; Jour. de Conch., 1877.

Whorls flattened posteriorly, and more or less keeled. Closely spirally ribbed, the ribs rounded but rather rough. Axis sub-perforated; aperture sub-rhomboidal. Dark purplish-black. L. ·23; B. ·25.

Hab. Auckland—Mr. T. F. Cheeseman.

Trochus (Cantharidus) texturatus, Gould.

This is the same as *C. purpuratus*, Martyn.

Trochus (Cantharidus) jucundus, Gould.

I have seen no specimens of this species.

"Shell small solid, low conical, composed of about six conical whorls, with a slight vertical portion at base; the whole girdled with fine, uniform, beaded lines, the alternate ones being generally smaller, sometimes even not beaded, and the two basal ones surrounding the vertical portion being larger; base a little convex, similarly sculptured with about twelve concentric lines gradually diminishing from the centre to the circumference; the umbilical region colourless, not perforated, and with a groove-like impression beside the columella; aperture rhomboidal-orbiculate; columella arcuate, smooth, lip simple. Colours arranged in radiating flamules, alternately white, strawberry-red, and pale flesh-colour, gradually shaded into each other; on the base the dark or light red are distributed along the granules in a somewhat articulate manner; nacreous beneath. Axis $\frac{3}{8}$ inch; diameter $\frac{3}{8}$ inch." *(Gould)*.

Trochus (Margarita) pupillus, Gould.

I have collected what I take to be this species in Otago.

Gadinia nivea, Hutton; Jour. de Conch., 1877.

Irregularly oval, white; with about forty sharp radiating ridges, crossed by concentric lines of growth. L. ·8; B. ·7.

Hab. Otago.

Patella unguis-almæ, Lesson; Voy. Coquille, II., p. 420.

This is the same as *Tectura fragilis*, Chemn.

Patella redimiculum, Reeve.

P. pottsi, Hutton; Cat. Mar. Moll.

Patella stellaris, Quoy and Gaimard.

P. octoradiata, Hutton; Cat. Mar. Moll.

Patella luctuosa, Gould.

This is the same as *P. denticulata*, Martyn.

Patella argyropsis, Lesson; Voy. Coquille, II., p. 419.

P. decora, Philippi.

Patella pholidota, Lesson; Voy. Coquille, II. p. 420.

N. argentea, Cat. Mar. Moll.; not of Quoy.

Patella argentea, Quoy and Gaimard.

N. earli, Cat. Mar. Moll.; not of Reeve.

Siphonaria obliquata, Reeve.

S. diemenensis, Cat. Mar. Moll.; not of Quoy.

Siphonaria inculta, Gould.

This appears to me to be *S. zealandica*, Quoy and Gaimard.

Siphonaria diemenensis, Quoy and Gaimard.

S. denticulata, Cat. Mar. Moll.; not of Quoy.

Siphonaria læviuscula, De Blainville.

S. funiculata, Cat. Mar. Moll.

Marinula filholi, Hutton; Jour. de Conch., 1877.

Ovato-oblong, smooth, spire short; inner lip with three plaits, the posterior of which is much the largest, and the anterior the smallest. Outer lip without plaits. Pale purplish-brown, plaits white. L. ·35; B. ·2.

Hab. Auckland—Mr. T. F. Cheeseman; Massacre Bay—Dr. H. Filhol.

Leuconia obsoleta, Hutton; Jour. de Conch., 1877.

Small, thin, semitransparent. White with a thin brownish epidermis. Whorls four, very finely spirally striated in young shells. Columella rather flattened, anterior plait of the inner lip almost obsolete. L. ·1.

Hab. Auckland—Mr. T. F. Cheeseman.

Corbula haastiana, Hutton; Jour. de Conch., 1877.

Sub-trigonal, very inequivalve, covered with a brown epidermis. Rounded posteriorly, obsoletely keeled anteriorly. Right valve very finely striated; the left deeply grooved; ventral margin sinuated anteriorly. Yellowish-white. H. ·4; L. ·4.

Hab. Lyttelton—Dr. J. von Haast.

Myodora plana, Reeve; Conch. Ic., fig. 8.

M. brevis, Cat. Mar. Moll.; not of Stutchbury.

Mactra deluta, Gould.

This is the same as *Standella ovata*, Gray.

Mactra rudis, Hutton; Cat. Tertiary Moll. of N.Z., p. 19.

Standella inflata, Hutton; Cat. Tertiary Moll. of N.Z., p. 18.

Recent dead shells have been found in Wellington Harbour.

Psammobia affinis, Reeve.

P. zonalis, Cat. Mar. Moll.; not of Lamarck.

Tellina subovata, Sowerby.

T. lintea, Hutton; Cat. Mar. Moll.

Capsella radiata, Deshayes; P.Z.S., 1854, p. 348.

Psammobia affinis, Cat. Mar. Moll.; not of Reeve.

Mesodesma lata, Deshayes.

M. elongata, Cat. Mar. Moll.; not of Quoy.

Mesodesma spissa, Reeve.

M. cuneata, Cat. Mar. Moll; not of Lamarck.

Venus calcarea, Gould.

Probably a worn specimen of *C. yatei*, Gray.

Diplodonta striata, Hutton; Jour. de Conch., 1877.

Lucina novo-zealandiæ, Reeve; not *L. zealandica*, Gray.

Lucina inculta, Gould.

This is the same as *Diplodonta zealandica*, Gray.

Crassatella obesa, Adams; P.Z.S., 1852, p. 90.

Gouldia isabella, Hutton; Cat. Mar. Moll.

Mytilus latus, Chemnitz.

M. smaragdinus, Cat. Mar. Moll; not of Chemnitz.

Modiola fluviatilis, Hutton; Jour. de Conch., 1877.

M. securis, Cat. Mar. Moll; not of Lamarck.

I have specimens from the neighbourhood of Dunedin.

Avicula lurida, Gould.

Dr. von Martens appears to have made a mistake in putting this species into our list. Mr. Gould says that it comes from Fiji.

Avicula glabra, Gould.

Avicula fucata, Gould.

I have seen no specimens of either of these species, and believe the locality to be wrong.

Pinna senticosa, Gould.

This is the same as *P. zealandica*, Gray.

Nucula sulcata, Adams, P.Z.S.

N. consobrina, Cat. Mar. Moll; not of Adams.

Leda concinna, Adams, P.Z.S.

L. australis, Cat. Mar. Moll; not of Quoy.

Pecten australis, Sowerby.

Hab. Foveaux Straits—Mr. C. Traill.

Lima angulata, Sowerby.

Hab. North Island—Mr. T. Kirk.

Lima japonica, Adams.

L. bullata, Cat. Mar. Moll; not of Born.

Ostrea chiloensis, Sowerby.

O. virginica, Cat. Mar. Moll; not of Lamarck.

Ostrea glomerata, Gould.

O. mordax, Cat. Mar. Moll; not of Gould.

Ostrea reniformis, Sowerby (?).

The rock-oyster of Dunedin.

Art. XLI.—*Notes on a Marine Spider found at Cape Campbell.*

By C. H. Robson.

[Read before the Wellington Philosophical Society, 24th February, 1877.]

My attention was first directed to our numerous spiders by an interesting account of the trap-door spider by Mr. R. Gillies.* After having read the paper above quoted, I began to collect specimens of such spiders as were to be found about Cape Campbell, more with the hope of finding some of the trap-door variety than of discovering a new one.

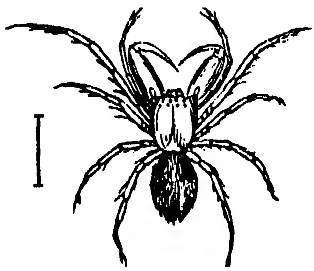
Soon after this one of my boys told me that, while playing on the cape at low water, he had seen a spider in one of the tidal pools. Never having heard of the existence of a sea-spider, I thought he must have made a mistake; and I was more disposed to think so when I began to consider that, even if a spider could live in the sea, he could not do so without food, and he would not find any flies or beetles there. I may here remark, that up to the present time I have not been able to discover what these spiders do live on. But to return to my boy's discovery.

On going to see what it was, I found a veritable spider quite at home under the water, and having a nest in an old *Lithodomus* hole, of which the rocks about here are full. All the spiders of this kind which we have found have had nests in these holes, and always under water at all times of the tide. Over the mouth of the hole the spider spins a close web, which

* Trans. N.Z. Inst., VIII., Art. XXXI.

when finished looks like a thin film of isinglass, and is water-proof; and behind this film is the nest and egg-sac, which last is of various shapes and contains a large number of eggs.

When the spider is disturbed it goes to the bottom of the pool, and if a small stick or straw is extended to it it at once gets ready for a fight, advancing its long and powerful mandibles for that purpose. The strength and formidable nature of these is well shown in the illustration which accompanies this paper, and for which I am indebted to Mr. A. Hamilton, who is also a member of the Society.



When a small fish is placed in a bottle of water with one of these spiders, the latter will attack at once, driving its long sharp falces into the fish near the head and killing it instantly. Each spider seems to live in solitary state, and it is, I believe, an exceedingly pugnacious little animal; but I have not had the time or opportunity for studying its habits closely, and regret not being able to give more information respecting it.

Each spider seems to be of two colours, the cephalo-thorax being a red-brown and the abdomen of a greenish hue, these colours becoming more distinct when the spider is placed in spirits.

[NOTE BY DR. HECTOR.—This spider is allied to the genus *Argyronetra*, of which *A. aquatica*, the water-spider of Britain, is a well-known species. It differs from the generic characters given for that in the position of the ocelli, which are of equal size, eight in number, and arranged in divergent pairs. I can find no record of a species of water-spider inhabiting the sea, and, as Mr. Robson points out, it is difficult to conceive what can be its prey, unless it be insects that accidentally float on the surface. The water-spider builds its nest and hatches its young under water, constructing a diving-bell which it keeps supplied with air by bubbles entangled by the hairs which cover the abdomen and enclosed by the legs. For this species I propose the name *Argyronetra marina*.]

ART. XLII.—*Description of Trap-door Spiders' Nests from California and from Western Australia in the Christchurch Museum.* By. R. GILLIES, F.L.S.

Plate XIII.

[*Read before the Otago Institute, 9th October,* 1877.]

In November last, when in Christchurch, I had the opportunity, through the kindness of Dr. Haast, of examining four trap-door spiders' nests from California and two from Western Australia, which are deposited in the Canterbury Museum, and which I was informed have never been examined or described. Each nest or trap-door has special features of its own which I will point out afterwards, but there is a very marked distinction between the Californian nests and the Western Australian, and between each of them and our New Zealand species. The Californian nests have all thick doors bevelled at the edge, and fitting tight into the mouth—the outside of the trap-door being level and coincident with the surface around—they are, in fact, true "cork nests." The South Australian ones have the mouths of the nests raised above the surface around; they are really on little hillocks or protuberances of the ground and have the trap-door fitting on to the top of the mouth as a cap overlapping all round and raised in the centre like miniature tea or coffee-pots with lids to them. A reference to my paper on the New Zealand species* will show that they are quite different from either of those types. In that paper I stated that I was inclined to think the distinctions laid down by Moggridge between cork nests and wafer nests did not hold good so far as the Oamaru species is concerned. My examination of these nests has revealed to me that what Moggridge referred to as cork nests was something quite different probably from what I understood.

The distinction between cork nests and wafer nests rests mainly on the thickness of the door, and as he gives no measurements as a guide, I fell into the mistake of thinking that the extremes of the thicknesses would be within reasonable limits as compared with the size of the nest, and hence I said that "doors of all degrees of thickness are to be found and that this distinction does not hold good." I find now that these Californian nests have their doors so excessively thick in proportion to their size as at once to justify the distinction of cork nests, and therefore that our New Zealand species, with all their varying thicknesses of door, are all wafer nests. These foreign nests, now about to be described, are also very much shorter than those of our New Zealand species, and in this they approach more nearly to the Jamaica nest in our own museum, and described at the end of my paper mentioned above. It is believed that the ultimate classification

* Trans. N.Z. Inst., VIII., Art. XXXI.

of trap-door spiders will depend largely on the type of nest which they construct. It is therefore of much more importance than might at first appear, to have full and correct descriptions of nests, and this must be my apology for the somewhat minute detail which I shall now enter upon. In a question where the principles of classification are still undetermined, it is obviously impossible to say what is of value and what is not. It is, however, greatly to be regretted that, as in the case of our Jamaica nest, the ingenious constructors of the nests, now about to be described, have been lost, or destroyed by insects, and hence it is now impossible to connect these nests with any particular species of trap-door spider.

Nests from California.

No. 1 is in soil of red volcanic clay or loam, and there is no herbage of any sort about it. The clod contains the whole nest complete and is only 4½ inches deep, so that the nest is only that depth, and, therefore, very much shorter in proportion than any of our New Zealand nests. The nest (fig. 1) is slightly tortuous, but contains no enlargement, and this is different also from most of our New Zealand ones. It is lined throughout with a tough lining, and partakes more of the character of a pouch or sack than a tube, and in this approaches nearer to the Jamaica nest in our own museum. In shape it is oval, the short axis of the oval being across from the hinge area to the front or lip of the trap-door. But it is in the shape and formation of the trap-door that this nest differs most essentially from our New Zealand nests. It is thicker next the hinge than at the front, the relative thicknesses being $\frac{3}{10}$ of an inch and $\frac{1}{10}$. It is thickened from the under side, and not on the top or outside as in other nests, and the hinge is a continuation of the lining of the nest (fig. 2) extended over the upper or outside lining of the trap-door which is parallel with the surface ground. This is important, as it goes to show that there has been no enlargement of the nest from time to time. In our species, and in those described by Moggridge, the thickening and tiling of the trap-door has evidently arisen from the spider widening its hole and adding on a new and enlarged trap-door on the under surface, the hinge being always attached to the new and enlarged trap-door. But in this case no such process has been followed—in fact, there is rather evidence of the opposite, for half-an-inch in front of the mouth of the nest, the remains of part of this or of another nest is seen sticking through the soil. It is possible, however, that the original top of the nest may have been removed and that this is an entirely new one. The lid is concave on both surfaces, and the edge is bevelled so as to fit close into a corresponding countersinking in the mouth of the nest like a cork or plug. The hinge is unusually long and straight, being nine-tenths of an inch long, whilst the extreme width of the trap-door is only one and one-tenth of

an inch and forms a straight segment across one side of the oval (fig. 3). The hinge has no spring in it, but the material may have lost its elasticity, though from the shape of it I don't think it ever had any spring. The trap-door requires some force to open it from the closeness with which it fits into the mouth of the nest, but once it is opened it easily remains open. This trap-door bears very plainly the markings or punctures alluded to by Moggridge and Gosse and referred to in my former paper. On the under side of the lid in front there are four distinct sets of markings in the centre of the free edge of the lip (fig. 4). There are two sets of four holes or slits, each in the centre separated by a wider space of about a line, and then other two sets, one on each side separated from the others by a wider space of about a line, and forming a row of more minute holes for about a quarter of an inch on each side of about a dozen placed irregularly. Whatever these markings are, and the general symmetry of them is peculiar, they are certainly not air-holes as suggested by Gosse, for the holes do not penetrate through the lid. The lining of the trap-door is very tough, and the outside is covered only with red loam corresponding with the soil surrounding.

No. 2 is a sod 3½ inches deep with only the upper part of a nest and the trap-door complete. What there is of the nest is nearly straight or has only a slight bend. The lid is flat on the upper side (fig. 5), and is thicker at the hinge than at the free edge, the proportion being four-tenths of an inch and two-tenths. The thickening, as in the last case, is entirely on the under side, and the hinge is attached to the upper or outer lining of the trap-door. The free edge is markedly bevelled, being quite sharp at the edge, then concave, and then convex all round (fig. 6.) The mouth of the nest is counter-sunk for two-tenths of an inch in width and four-tenths deep, corresponding exactly to the edge of the trap-door so as to receive it accurately like a valve. The outer side is coated with plants and when shut falls into the counter-sinking about two-tenths of an inch below the surface, but this may be caused by the drying up and shrinking of the material. The under side is covered not so much with close woven cloth as with innumerable coarse threads of spider web, easily distinguishable by the naked eye, and there are no markings whatever on it. As in the last case the hinge is unusually long, and forms a straight segment across the round of the trap-door; but the great peculiarity of this nest, and one which distinguishes it from any I have ever seen, or that has ever been described, is that it is not hinged all the way across at the hinge area, but has two hinges (fig. 7), one at each extremity of the hinge area, separated by an unattached part between them. These hinges are very tough, and are respectively two-tenths and three-tenths of an inch wide. The back

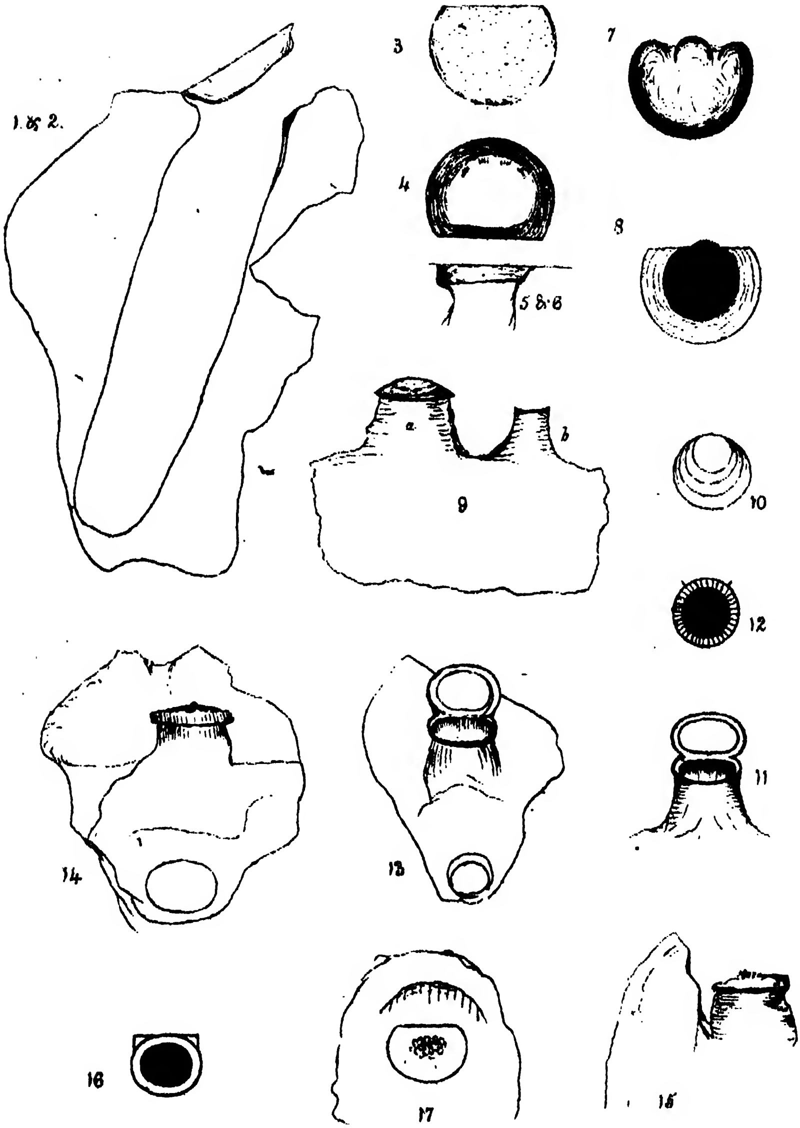
part of the lid on the under side is protuberant, as shown in fig. 7, at the part that is unhinged, and it is there the lid is thickest. There is, too, an indent into the side of the lip of the nest opposite this protuberance on the lid, and into which it fits as shown in fig. 8 (which represents mouth of nest with the door off) causing the lid, when shut down, to lock, as it were, like a dove-tail, so that in order to open it again you have to insert a knife between the trap-door and the mouth of the nest. This trap-door with its hinges, locking apparatus, and counter-sinking is, I think, one of the most marvellous mechanical arrangements that I have ever come across in nature. No one can attentively examine this ingenious contrivance without being impressed with the fact that here in one of what we are accustomed to call the lowest class of animals, we have something wondrously akin to the inventive faculty in man. But this paper is one of facts and not speculations, and so I must forbear. As in the previous instance there is no spring in the hinges, so that the trap-door remains open when left open. Though the outside appearance of the trap-door represents the segment of an oval, still the contour of the hole inside below the counter-sinking is nearly circular as shown in fig. 8.

Nos. 3 and 4.—The other two Californian nests are in the same character of ground as the preceding, and are of the same shape, and have the same description of hinge as No. 1, only they are both of smaller size. They are both thickened on the under side and bevelled on the edges like the others. No. 3 though hinged across has a protuberance slightly developed on the under side of the lid in the centre of the hinge area the same as No. 2, suggesting the idea that possibly the two hinges in that nest may have been caused by the locking effect of the protuberance as it is increased in size, but there is no evidence of unfinished or wraggled edges in No. 2 indicative of the separation having been effected by such a wearing process. On the under side of the lid of No. 4 on the free edge there are two distinct holes or claw marks exactly in front, but they do not penetrate through the lid. Both nests are lined with very tough web, are tortuous, but have no enlargement.

Nests from Western Australia.

These two nests (which were presented by His Excellency Governor Weld) differ entirely from the Californian. They are raised above the surface of the ground, and the lid fits on to the mouth of the nest like a cap, overlaps somewhat all round, and is thickened entirely on the outside. They are also smaller in size than the Californian.

Nest No. 1 is almost circular (fig. 9: *a* trap-door closed; *b* small nest without lid); across the mouth outside it measures six-tenths of an inch, whilst the lid fitting over it measures seven-tenths; across the mouth inside



NESTS OF TRAP-DOOR SPIDERS.

To illustrate Paper by R. Gillies.

R. Gillies del.

it measures four-and-a-half-tenths, and the space or ring between the inside and outside is bevelled slightly. The inside of the lid or trap-door is level, or nearly so, with the hinge, the thickening being entirely on the upper or outside of the lid. The outside edge of the lid is thin and overlaps the outside mouth of the nest like a fringe, the portion of the under side of the lid which corresponds to the bevelled or counter-sunk part of the mouth of the nest being depressed a little (fig. 11). The centre of the under side of the lid fitting on to the actual hole in the mouth of the nest protrudes a little into the nest, the whole arrangement being exactly the same as a water-tight valve covered with leather. The lid is therefore not a cork one, and does not go into the mouth of the nest at all, being large, but fits like a cap or Scotch bonnet. Nor, on the other hand, can it be said to belong to the other or wafer type of lid, as though it thins to an edge all round it thickens to the centre very symmetrically till it is at least two-tenths of an inch thick at the thickest part. The outside contour of the lid is rounded off, but at least four or five old lids can be detected, giving it a tiled appearance like an oyster (fig. 10). The hinge, which is large for the size of the nest (four-tenths of an inch) is attached to the outside edge of the bevelled part of the mouth of the nest (fig. 12). The inside of the lid and nest is covered with tough lining; the outside of the lid has simply the soil cemented together by threads, forming a thin covering, and remains of some mosses or lichens are still visible on it. The mouth of the nest and the lid is raised half-an-inch above the surrounding ground, and another smaller nest three-tenths of an inch wide, and also raised above the ground, is in the same sod within an inch of it. The lid, however, of the small one is gone, and the whole sod is only an inch and a-half deep, so that there is only a portion of the nest, and nothing can be said as to its former length.

Nest No. 2 is of the same type as No. 1, the outside of the mouth being six-tenths across, inside four-and-a-half tenths, whilst the lid is seven-tenths. The mouth is raised above the ground, the lining being very tough and thick, and overlaps the ground a little, causing the appearance of a bevelled mouth. The lid is flat below, and overlaps the mouth slightly, forming a fringe. There is a depression all round the inside of the lid where it fits on to the mouth of the nest (fig. 13). The lid is thickened entirely on the outside, but, in contrast to the other, is as thick at the edges as elsewhere (fig. 14, front view), giving it a very odd but finished appearance. At the hinge area it is a little thinner than elsewhere (fig. 15, side view). The hinge is attached to the outer edge of the lining of the mouth, and is large for the size of the nest, being five-and-a-half-tenths. It differs from all others that I have seen in this: that it does not follow the round of the mouth, but is extended out at each edge beyond the circle

like the ears of a scallop shell (fig. 16, nest open). The outside of the lid has no tiling, but is formed of soil cemented together, and has remains of lichens on it (fig. 17, vertical view). The lid fits tight as a flap, and has no markings on its under side. The soil of this sod is a light brown loam; and an odd peculiarity in this nest is, that a space for the nest and for the lid has evidently been excavated (fig. 15) out of the sod or soil so as to allow of the lid opening back, which it does freely without spring, and remains open.

Art. XLIII.—*Notes on some Changes in the Fauna of Otago.*

By R. Gillies, F.L.S.

[*Read before the Otago Institute, 11th September, 1877.*]

The writings of Darwin and others have made us familiar with the theory of natural selection, and given a new impetus and a definite meaning to the investigation of biological phenomena which previously were looked upon as isolated unrelated facts. Amidst all the turmoil and strife which the enunciation of this hypothesis provoked, perhaps there was nothing which excited less dispute than the assigning of the passing away of ancient races, and their being supplanted by new and more vigorous species, to the principle of the survival of the fittest, and there was no class of facts more freely and frankly admitted as such, than those which in such countries as Australia, South America, etc., demonstrate that the indigenous species have very quickly retired before and been supplanted by foreign introduced forms. It may, therefore, seem almost superfluous to supplement these facts in any way. But I am inclined to think that most people are not sufficiently impressed with them, and hence fail to grasp their meaning. At any rate I am quite sure that to those who have seen and observed similar phenomena, these changes appeal with a cogency which, to the ordinary reader is a-wanting. The forms of life which we see around us now in New Zealand are not the forms which peopled and clothed our hills and valleys, woods and plains, even a quarter of a century ago. The change, though rapid, and in some cases complete, has been silent and continuous, and hence has escaped observation, and it is only by casting the memory back to what was the state of matters years ago that we realize how much the conditions of things have changed. Hence it is, too, that a detailed and exact record of such changes is impossible, and that we even now find a difficulty in obtaining such reliable data as is desirable for our purpose. Were it possible to foresee what forms were likely to be modified or were becoming extinct, then

care could be taken so to conduct observations as to ensure results which could be tabulated with all the accuracy of numerical precision. But in the nature of the case this is impossible. We have changes going on now under our notice. Old forms gradually passing away, and new ones coming on the scene in their place, but who is to foretell what is doomed and what is to endure? No doubt much may be done and is doing with a view to the future. But the irrecallable past is gone without the data being preserved which now we wish we had, and it only remains for us to save the shreds and patches which linger in the memories of old settlers. These must necessarily be imperfect, but, as the only thing left to us, may not wholly be valueless, and to the younger generation growing up amidst the new order of things cannot be entirely without interest. It may be, too, that the following few scraps culled from my own experience and memory may be the means of inciting others possessed of fuller and better materials to put them on record in a simple form for what they are worth. Who knows, if this hint is acted upon, but we may yet have a record of the past of our fauna and flora as complete as I am quite certain it would be startling in comparison with the present.

I shall first refer to changes in our fauna, and, as the most practical and direct way of doing so, shall relate some facts connected with some that have passed or almost passed away—beginning with insects, then referring to a few birds, and then to the only mammals existing as wild in my memory; referring at the same time to some new forms that have been introduced and are now prevalent everywhere. I shall then pass on to such marked cases in the flora of the country as have come under my own notice, treating them in the same way. I shall then, if I have time, discuss some of the causes which have operated in producing the results referred to, and try to indicate in what directions our observations and efforts should be directed in future.

One of the greatest insect pests in Otago twenty-five years ago was what was called the common blow-fly—a large blue-bottle fly. It swarmed everywhere, and people now-a-days will hardly believe the trouble and annoyance which it gave to the early settlers. No woollen material could safely be left lying at rest for even a few minutes without running the risk of having the small white eggs of this fly deposited in large numbers and fixed in the fibres of the material by the glutinous envelope surrounding them. A working man took off his blue serge shirt and threw it down carelessly (and every man in those days was a working man and wore a blue shirt), in a very short time when he went to pick it up he would discover to his annoyance and disgust that it was fly-blown, and not very long after he would find it a crawling mass of maggots. If in his fear of the

maggot stage he precipitately proceeded to get rid of the eggs, he would soon discover that he had only succeeded in making matters ten times worse, for in his vain endeavours to rub or scrape off the eggs he was sure to burst most of them, the outer skin of which thereby became indelibly glued into the material, presenting for ever after the disgusting appearance of a dirty white blotch or stain on the garment. Experience soon taught the early settlers that the only effectual mode of remedying the evil was to wrap up the garment till the eggs were hatched out into the larval stage, when a smart shake of the outspread garment at once freed it from all trace of the nuisance. The evil was always worst in warm damp weather, but it was not confined to such days, nor to woollen materials lying at rest in the open air. For a long time it was absolutely necessary and commonly practised to wrap up all woollen materials in close calico bags—even the very blankets on beds had to be rolled up and wrapped in calico soon after the night's repose, and it was rare in those days to see blankets that had not been disfigured by the disagreeable stains alluded to, for once the eggs were burst there was no washing out of the mark afterwards.

I am indebted to W. D. Murison, Esq., editor of the "Daily Times," for the following note on this subject, and subsequent ones on other fauna, which I shall read in their several places:—"It was common to take the blankets from the bed in the morning, if the weather was fine, and hang them over a rope. They would not then be 'blown,' as there were no folds."

I remember on one occasion going on a fishing excursion to the Silver Stream, for in those days everybody was possessed with the fond belief that New Zealand would beat the world for fishing or shooting, or, for the matter of that, for any other natural production to be found in any country on the face of the globe—one of our infantile illusions long since got rid of. It was a warm damp night, on which, according to all orthodox rules of the piscatorial art, we ought to have had plenty of sport. But a drizzling rain and empty baskets sent us home in the early morning only for me to discover that my fine waterproof mohair overcoat, recently brought from home and looked upon as an invaluable companion in a land of few accommodation-houses and no umbrellas, was one mass of maggots everywhere. My inexperience made me disgustedly pitch it on the dung-heap, from whence it never reappeared, at any rate as a coat. Another instance: My father bought a property and run in the Tokomairiro district in 1852. There was no possibility then of taking any wheeled vehicle from Dunedin, and hence all goods and provisions were shipped in small coasting craft and sent round by sea to the Taieri mouth and landed at the head of the Waihola Lake. For in those primitive days it was officially impressed upon

all intending emigrants that the fine natural waterways which traversed the Otago block were kind dispensations of Providence for the special benefit of the Free Church settlement not accorded to the rival Church settlement in Canterbury, and which effectually precluded the necessity for such expensive new-fangled contrivances as railways. It is true that shipments of flour or goods generally have been known to be detained for months at the Heads waiting a fair wind; but time was not of much value then, and if settlers could not get their things, they had just to do without. Well, on one occasion we (my brothers and I) heard that the boat had been round and landed a lot of flour, sugar, etc., for us at the head of the lake. It so happened that it had been very wet weather, and the rivers and creeks were flooded to such an extent that it was impossible to bring home such commodities on the sledge without great loss; so one of us went down to the lake with a large woollen waggon-cover, exactly the same as those used by carriers in the old country. With this large new cover the goods were all securely protected from rain at least, for from rats there was no escape. Unfortunately the wet weather continued, and from the long rough herbage that everywhere covered the country the water was retained, so that it was six weeks before the creeks became sufficiently low to bring these goods home. You may judge of our annoyance and disgust when we went for them to find the large woollen cover one mass of rottenness crawling with maggots which had eaten away yards of it, and reduced it all to a useless mass of rags. So common and prevalent were these blow-flies that no damp or greasy surface was safe from them, even though not woollen. I have seen an iron crowbar that had been grasped by a greasy hand fly-blown in a very short time. As for mutton or beef it could scarcely be placed steaming on the table before these pests would attack it, and it was rare in the summer time that you used your knife and fork without having to remove from the crevices of perfectly fresh and wholesome meat the small living larvæ of these flies. Many of you may think that this was bad housewifery, or that I am greatly exaggerating, but it is not so. A story used to be told of an old lady at Clutha, who in her endeavours to keep cooked meat free of these pests, adopted the plan of putting it into a very large tin kettle, but she soon found out it was of no use, for, as she said, "the nasty things just ganged down the spout."

Mr. C. H. Street tells me that on one occasion, many years ago, he was out pig-hunting at the back of Warepa bush along with a gentleman now holding a high judicial position in the north, and that being unable to carry the pig which they had killed and disembowelled, they were compelled to drag it along some distance on the fern and grass. On looking back some one hundred yards they were astonished to see the broad track

formed by their dragging the carcass literally black with millions of blow-flies, and not one on any other part of the ground or herbage." Mr. Murison remarks:—"Camp ovens were almost the only hiding-place for cooked meat which were secure from the attacks of the blow-fly."

No person now can have any conception how numerous and unavoidable these universal pests were. One strange and most fortunate thing was that these flies never attacked or laid their eggs in the wool, or any part of the living sheep. In Britain a similar fly is a terrible scourge to the flock-master, producing the fatal disease known as maggots or blow-fly, which will run through a flock in a short time, sometimes before it is noticed. It is easy to conceive what the result would have been here with sheep roaming over the face of the rough country for months often unshepherded. Sheep farming would have been an impossibility. But never in these years nor since, have I ever come across or heard of a genuine case of maggot running through a flock. Mr. Murison says:—"Sheep that were 'cast' were soon attacked by the blow-fly, but these were the only cases I think." Now we may almost say that the blow-fly has disappeared. Its place in nature has been taken up by the smaller common house-fly, *Musca domestica*, a more annoying insect to a sleepy man in a hot summer day, but not at all so disgusting. In the days I have been speaking of there were no house-flies, but gradually they appeared, first in Dunedin, and were much talked about, then step by step, season after season, they extended in an ever widening circle till they overspread the whole province, entirely supplanting, by the inexorable law of the survival of the fittest, the genuine old-identity blow-fly.

Another insect pest which was very prevalent twenty-five years ago, and has now all but disappeared everywhere, was the mosquito, *Culex acer*. The mosquito was unknown in Great Britain, and all our ideas with reference to it are associated with hot tropical climates, so that it may appear to many of you almost startling to say that, in the early days of Otago, the mosquito was a great nuisance in the summer time. Still it is true, they were met with everywhere, though certain situations and localities were more notorious than others for their depredations. These were mostly low-lying situations near bush or swamps, but the tormenting pests were not by any means confined to such localities. During the summers of '52 and '53 I lived at the Waikari, near Dunedin, elevated some 600 feet above the level of the sea, and I well remember the dense clouds of mosquitos that used to congregate towards the ceilings of the rooms in the evening after the lamps were lit. They never were bad for biting there, the principal annoyance being the singing noise, which constantly kept one in nervous dread of an impending onslaught. But in the Taieri Plain the settlers did

not escape so easily, and dire tales of unrest and suffering were constantly recounted by hapless wights who had to spend a night anywhere on the great Taieri swamp, as it was termed in those days. There was a totara-bark house in the bush at the Taieri village, known as Milne's accommodation-house, that was noted far and wide for mosquitos; and amidst the wondrous tales of adventure and discomfort which every traveller in those days had to tell, the nocturnal sufferings endured, and the expedients tried, to escape from the mosquitos at Milne's accommodation-house, always bore a prominent part. The Tokomairiro Plain, on the other hand, was never considered bad for mosquitos, though up near the bush there were always plenty of them. The Molyneux Island, on the other hand, was notoriously bad; but it must be borne in mind that in those days this Ultima Thule of the Otago block was classic ground for all the wild tales of hair-breadth escapes, privations, and adventures that could possibly fall to the lot of a New Zealand colonist. But you must not suppose that I wish you to think the tales about mosquitos were mythical. I will come to actual facts within my own experience and observation. In the years 1856–8, before the country was settled, I was engaged as a government officer surveying the Waihopai, New River, and Mataura Plains trigonometrically, and of course lived entirely in tents. The mosquitos were, I can assure you, anything but myths, especially on the New River. On retiring to our tents in the evening, we tried to get rid of them by burning green branches, cow-dung, or anything that would make a dense smoke to drive them out, and then quickly and carefully closing up the curtain of the tent endeavoured to pop off to sleep before they made good their entrance again. But, alas! we soon found that the chances of success were small indeed, for those that had fallen stupefied to the ground with the smoke soon revived, and the first noise of the singing of their wings was the signal for the breaking out of an infernal chorus from all those that had been secreted about the blankets and fern forming our beds, who all sallied forth with bloodthirsty energy to revenge the retreat of their fellows upon the now prostrate and passive foe. Then, if "tired nature's sweet restorer" had not already "paid his ready visit," good-bye to "balmy sleep." So intolerable and incessant was the nuisance that at last I hit upon a plan which completely baffled them, and I could go to sleep with myriads buzzing round me and awake in the morning unharmed. For the benefit of all travellers, I must tell you what it was. In the first place I wrapped myself round in an opossum rug with the skinny side out. This they could not penetrate through, for it is a fact that they will penetrate through ordinary blankets. For the protection of my head and face, which, of course, had to be outside the rug, and were the

most vulnerable points, I took a piece of stiff drawing-paper and bent it over my head in the form of the old scoop-bonnets of our grandmothers. I then took a large piece of mosquito netting, and put it all over my head and face, and tied it firmly round my neck below the level of where the opossum rug was tucked in. In this way the netting did not inconvenience me in breathing, and was kept sufficiently far off my face to prevent my enemies stinging through it. For two summers I constantly lay down to sleep with this paraphernalia on my head, and I can assure you if you had looked in on me you would have thought me a very comical sight, but what matter about that, it secured me repose. Not so, however, my poor men, who had no mosquito netting. Many a night when I have happened to awake have I heard them tumbling about in the adjoining tent swearing at those mosquitos. And in the morning, to see them turn out haggard and weary, with perhaps an eye almost closed up or cheek swollen to undue proportions with the onslaught made on them during the night, I confess it required a harder nature than mine to refrain from pitying them. Though I must say they always made light of it, but then, in the early days, there was a romance in everything which made men glory in difficulties and discomforts, and even make fun of hunger and risk of life. I remember one season on the New River I had a new chum, fresh landed from the ship, as a chainman. That man was such a martyr to mosquitos that he always slept during the whole summer with all his clothes on him even to his very boots. He suffered so much that I would have discharged him had it not been that he was a first-class hand. Extraordinary though this may appear to you, it can be verified, for the man is alive to this day, and can be found as a successful settler not far from Invercargill.

It may seem almost ridiculous for me to tell you that fleas, *Pulex irritans*, were much more numerous in the early days of the settlement than they are now, for you will be sure at once to jump to the conclusion that that was owing to the necessarily semi-savage habits of the first settlers and to their contact with the Maoris. No doubt, as better houses were built and more civilized habits became possible, these insect pests had not the same chance as before, but this does not account for all the change. The Maoris, too, with their pigs and their dogs can, in other parts of New Zealand, account for a great deal of what was in those days, *the special characteristic of New Zealand*, but inasmuch as there never were many Maoris here, and they were hardly or ever employed or kept about the settlers' premises, this cause had practically no existence here. And yet, go where you liked, in town or country, the fleas were masters of the situation, and were more talked about than even the Crimean war. The whole face of the country was covered everywhere with a dense impenetrable

thicket of herbage, principally fern, tutu, and flax, and before this was burnt you could not lie down or go amongst it anywhere without being covered with fleas. Great differences of opinion used to exist as to whether these fleas were the true genuine flea (*Pulex irritans*), and there is no doubt they were not so active nor so bloodthirsty and irritating as their brethren, which infested all domiciles alike. About these latter there was no room for doubt, for there was no lack of energy about them, and no difference in their bloodthirsty predatory habits. I remember, on one occasion, camping out close to the west end of the West Taieri Bush, and after a night of energetic wakefulness following on a day of weary travel on foot with a heavy swag, killing hundreds of them in our blankets when we turned out in the morning. More than once I have seen, on entering a hut that had been shut up for a few hours, one's white moleskin trousers become gradually blacker and blacker with the innumerable fleas that swarmed on to the white object on the floor. The same kind friend to whom I have already alluded, sends me the following on this subject:—"In confirmation of what you say about the fleas, I may state that in the summer of 1856-57 I was one of several occupants of a bark hut on an island in the Molyneux River. The floor of the hut was the greyish-blue sand which is everywhere to be seen on the banks of the river, and it formed an excellent harbour for the fleas, which were exceedingly abundant and very troublesome. On one occasion, being cook for the day, I became so irritated by their bites when I was working before the fire that I took off my canvas trousers, turned them outside in and ran my two thumb nails along the lining, destroying all that did not jump away. The tally of slaughtered ones was *seventy-six*, but many more than that must have escaped. An hour after my anathemas were once more both loud and deep." I could recall many circumstances to prove how extremely prevalent the fleas then were, but it would extend this paper to an undue length, and I believe it is quite unnecessary, as the fact will not be questioned. After the rough herbage, especially the fern, was burnt once or twice this insect pest almost disappeared, or at any rate became confined to its legitimate purpose in nature, that of a punishment for the want of cleanly household habits. I am not aware that anything else has taken the place occupied by this insect in the economy of nature, but its extinction (or reduction rather within proper bounds) has been brought about not by competition with other forms, but by the agency of fire.

The *Aphis lanifera*, or American blight on apple trees, is an insect which was quite unknown here for many years after the settlers had gardens; but when it first appeared, which I think must have been about fifteen or twenty years ago, it spread everywhere with most marvellous rapidity. So also did another insect of the same kind, which attacked the large

Cruciferæ, cabbage, cauliflower, turnip, etc., about the same time, and was not previously known in the country.

But blow-flies, mosquitos, and fleas were not the only insect nuisances which the early settlers had to endure. For pertinacity and genuine sanguinary annoyance I think I will back the New Zealand sand-fly against them all. Near the beach, especially a sandy beach, or on the edge of a bush, these insects swarmed in millions; and in warm close weather, just before rain, their attacks were most ferocious and venomous. They were considered very good indicators of the weather, for settlers used to say, "It will be rain to-day, for the sand-flies are biting!" So numerous and ferocious were they, that even Captain Cook specially refers to them as being peculiarly harassing during his visit to Dusky Bay in this province. He says (p. 331): "The most mischievous animals here are the small black sand-flies, which are very numerous and so troublesome that they exceed everything of the kind I ever met with. Wherever they bite they cause a swelling, and such an intolerable itching that it is not possible to refrain from scratching, which at last brings on ulcers like the small-pox." And in a book of such dry official details as the "New Zealand Pilot," p. 261, it is stated:—"The sand-flies noticed by Cook are of a most virulent kind, and it was with great difficulty that the necessary astronomical observations on shore could be made by the officers of H.M.S. "Acheron," who were frequently compelled to take refuge from their torments among the thick foliage a short distance from the beach, where, strange to say, they do not penetrate; these plagues invariably left the vessel at dusk, and did not reappear until the following daylight." This refers to some of the West Coast Sounds, where no doubt they are still numerous; but many times in other parts of the province, when observing important trigonometrical stations with a theodolite, and consequently unable to defend myself, I have seen my hands and face one mass of blood from the inveterate attacks of these insects. Now, you will scarcely ever hear of the sand-fly, and no doubt many new colonists don't know what it is. My belief is that the climate of this province (at least the eastern portion of it) is now very much drier than it was, and that this accounts in a large measure for the almost total disappearance of the sand-fly—a result certainly not to be regretted.

Passing on to birds: the parrakeet, *Platycercus novæ-zealandiæ*, still lives amongst us and enlivens the bush with its "twitter-twitter" and with its beautiful green plumage and rounded head, but as compared with the numbers which swarmed in every bush in the early days, it may be said to be almost extinct. To say that they were continually to be seen in flocks of hundreds gives you a very faint idea of the extreme prevalence of this

bird everywhere. Early settlers whose cultivations were in the bush (and almost all cultivation in the early days was confined to bush clearing) had always the greatest difficulty in saving their crops of wheat. For this lively roguish little bird defied all scarecrows, and even shooting them was found to be an endless and expensive job, for, though a few might be killed at a shot, the flock just rose and settled down again immediately a few yards off. I have known patches of wheat rendered utterly valueless by this now harmless bird; so rare and scarce have they become that I notice that country settlers near bush now have quite a warm side to the little green parrakeet and often make household pets of them.

The kaka (*Nestor meridionalis*), too, is a parrot that has almost passed away. In the early days they were always abundant everywhere, and were constantly shot for the pot by the settlers. At certain seasons they lived on the black pine-berries, and their presence on any tree could always be detected by the cracking of the stones of the berries overhead and the falling of the broken shells, even though the usually noisy screeching kaka was sitting close and still. In such a case it was almost always possible to secure as many as you wanted, even though there was only one on the tree or in sight, for all you had to do was so to fire as only to wound the first one, when he would set up such a screeching and cawing as would soon assemble all the kakas for miles round, when you could knock over as many as you wanted. Though always obtainable, the kaka was more plentiful at certain times than others, but whether he migrated or not, or where he migrated to, I know not. It was a general belief amongst early settlers that the kaka did migrate—it was thought to the woods on the west coast—but no authentic information was ever obtained that I have heard of. Some years they appeared in the settled parts of the province in flocks positively of hundreds. One year especially I remember (I think it must have been 1855 or 1856), they came in such numbers as to amount almost to a plague. Nor did they confine themselves to the bush, but everywhere, in open or in bush alike, on stacks, on fences, or on the ridges of houses, you would see them perched in rows as close as they could sit. I have seen them sitting on a post-and-rail fence in the Tokomairiro Plain so close together, that new arrivals had to fight for perching-room, and by shooting along the line of a fence you could knock over half-a-dozen at a shot. The destruction which they caused that year to stacks and to thatched houses, tearing them open with their powerful bills, was something enormous. I remember settlers used to discuss how they were to protect their property against this serious pest, which it was believed would increase every year as the area of grain culture extended. But curiously enough, the following year to that there were

almost no kakas, and they have never been so numerous since.' I have often tried to account for this sudden increase and as sudden decrease, but have only succeeded in making guesses which were dismissed almost as soon as discussed. On the east coast of the province it may be said this parrot has all but disappeared now; I have not seen one alive for years. Mr. Murison writes me:—"The beginning of 1861 was the greatest season for kakas I ever knew. I was then living in the Waikouaiti district, and for a time the birds became quite a pest to the settlers. They have not made their appearance in numbers since."

The beautiful New Zealand pigeon (*Carpophaga novæ-zealandiæ*) is a bird which we must all regret has almost passed away. It is rare, indeed, to see it anywhere even in places which used to be its favourite haunt. The patches of low evergreen bush in which the fuchsia tree flourishes, near Dunedin and along the seaboard, were the places where the pigeon loved to dwell, and where they could always be obtained in the early days. No settler then need ever want for a rich supper, and the poor pigeons were slaughtered somewhat indiscriminately. It used to be a common recipe amongst early settlers, that it took fourteen pigeons and one kaka parrot to make good soup. After making every allowance, however, for this wholesale slaughter, I am inclined to think that it does not wholly account for the almost total disapperaance of the pigeon. Naturalists are aware that though the order *Columbæ* is cosmopolitan in its range, yet the Australian region is richer in it than any other zoological area in the world, possessing nearly double the genera and species of any other region. This is accounted for by the fact that it is, to a large extent, an insular region, and has no monkeys or other arboreal quadrupeds which feed largely on eggs or young birds, the pigeon being a bird that builds a rude exposed nest, and whose young remain defenceless for a long time. This, I think, gives us the key to the disappearance of our pigeon, viz., that it is to the great increase in domestic and wild cats that we are indebted in a large measure for the change.

The quail (*Coturnix novæ-zealandiæ*) is another native bird, extremely plentiful in the open grass lands in the early days, but now so rare as to be valuable as a museum specimen. It is really difficult now to realize how plentiful these birds were. You could not walk far in the country, especially if you had a dog at your foot, without raising one here and another there. Dogs seemed to take to hunting them naturally, and made sad havoc amongst them, for they could not at any time fly far. Shepherds and flockmasters found it a very difficult thing to train young sheep-dogs aright, for in spite of no end of thrashing, when a young dog was sent out after sheep the temptation was too great for him, and "he would go

after these quails." Colonel Wakefield, in his official report to the directors of the New Zealand Company upon this part of New Zealand before the settlers arrived, gives special prominence to the fact that "quails are plentiful over all the downs and in the plains adjoining and would be more so but for the hawks and kites. Hereafter it will become the business of the Scottish sportsman to give rewards for their destruction." But a more relentless foe than even the dogs or hawks and kites was at hand to sweep away the New Zealand quail. The tremendous conflagrations, which everywhere overspread the country for years after the first settlers came, pretty nearly annihilated the quail. There was no escape for it, for it could only fly a short distance, whilst the rapidity and extent of these grand prairie fires left no chance of escape. This result was not noticed or perhaps thought of at the time, but when the short herbage began to reclothe the face of nature it was soon discovered that the quail had disappeared. I doubt very much if it could have survived in the now bare shelterless aspect of the country, and I question, too, whether such imported birds as the partridge or even the pheasant will increase very much until such time as more shelter is provided, and I am quite sure if the Acclimatization Society wish to make their efforts a success they will have to limit in some way the indiscriminate destruction of these birds which is now apparently legally carried on.

The native ducks of various sorts have not by any means suffered so severely as many other forms, but even they are not at all so plentiful as they were in the early days. One instance will suffice to show this:—In the early days, if a person had to make the journey between the Bluff and Invercargill on foot—and it was only on foot that he could make it then—he would have to ford a tidal creek known as Duck Creek. If the tide was in when he came to it, he would have to wade pretty well up to his chin—and of course with his clothes tied in a bundle on his head. It was a common and notorious thing to warn travellers in such circumstances always to carry a short stick with them in crossing this creek to ward off the ducks, which were so numerous and so bold as to be troublesome. Of course I do not vouch for the statement that they did attack people; they certainly did not attack me, and I had occasion often to cross; but, though an exaggeration, it certainly was current and believed in by many, and is of this much value to us, that it could never have been originated unless the ducks existed there in immense numbers and were peculiarly tame. I have myself come across scores of nests of the grey duck (*Anas superciliosa*), containing generally about a dozen eggs, amongst the tussock grass that then waved luxuriantly over the Southland plains. It is a rare thing now for anyone to find a grey duck's nest. Two years ago I found one in the

gorge of the Awamoko River perched high up on a ledge on the face of a rocky precipice, where in the early days they never would be found.

Most of the birds I have referred to are shy and wild, and it is possible may have been driven back from the settled districts into the wilder and more uninhabited parts, though I do not think so. But the weka, or wood-hen (*Ocydromus australis*), is a bold bird, and is extremely tame, delighting to haunt the environs of a camp and pick up refuse of all sorts about human habitations. It is rare indeed now to see its dignified stride or the odd sedate meditative nod of its head near a settler's dwelling, even in the country; whereas, even in Dunedin and its neighbourhood in the early days, no sooner did the evening shadows begin to close in than the peaceful calm which always set in after the habitual blow of a New Zealand day was sure to be broken by the peculiar call of the weka from every ferny brake and bushy dell. The lonely traveller then, camping out at the side of a bush, after having lit his fire and put on his billy, could always count on securing his supper by imitating their "cluck, clucking" cry, and without the bother of fire-arms, knocking them over by means of a stick with a red rag on the end of it. But, alas! fire and dogs have done their work all too effectually, and it looks very like as if the weka will soon be a bird of the past. Mr. Murison says;—"Wood-hens, I am told by a friend, are at present very plentiful in South Canterbury, where he says they will prove for some time a serious drawback to the successful acclimatization of the pheasant and partridge." He further says:— "The pukeko or swamp-turkey was unknown in the interior twenty years ago, and to the best of my belief was not then seen beyond ten miles inland. About 1862 it made its appearance among the swamps of the Maniototo Plains, and since then it has spread rapidly throughout the adjoining districts."

The rapidity with which certain introduced species of birds have spread over the country and increased in countless numbers is something marvellous. The wax-eye (*Zosterops lateralis*) was quite unknown for many years after the first settlers came, and now it swarms wherever there is a tree or a bush, in numbers only exceeded by the sparrow in the home country. It is believed to be of Australian origin; but the home birds introduced by the Acclimatization Society have also increased in a most wonderful ratio. It is only necessary for one to mention the starling (*Sturnus vulgaris*) in the open country, and the chaffinch (*Fringilla cœlebs*) in the neighbourhood of bush, to convince you of this.

As to mammals, Captain Cook, in his Second Voyage, states (p. 880):— "For three or four days after we arrived in Pickersgill Harbour, and as we were clearing the woods to set up our tents, etc., a four-footed animal *was*

seen by three or four of our people; but as no two gave the same description of it, I cannot say of what kind it is; all, however, agreed that it was about the size of a cat with short legs and of mouse-colour; one of the seamen, and he who had the best view of it, said it had a bushy tail and was the most like a jackall of any animal he knew. The most probable conjecture is, that it is of a new species; be this as it may, *we are now certain* that this country is not so destitute of quadrupeds as was once thought." Nothing answerable to this animal has since been discovered, and the only mammals existing in this part of New Zealand when the settlers arrived were the rat, the wild pig, and the wild dog. The first of these—the rat (*Mus decumanus*) was met with everywhere in great numbers. It was not confined to the neighbourhood of the settlements—Maori or whaling—but wherever you pitched your camp away in the wilderness, where never human foot before trod, there rats were found as abundant as near the settlers' homes. I remember distinctly on one occasion riding after a mob of cattle on a flat in the Taieri Plain near Otohiro in the year 1852, and seeing the rats running here and there in all directions from the horse's feet. When a new settler settled anywhere alone, the rats for a time were a perfect pest to him. They stole everything portable from him even to his candle-moulds, but after a time they became less and less numerous, and though they never disappeared wholly, yet nowhere in the country do rats swarm as they did in the early days. For years I was accustomed to camp out in new country miles away from any human being, but there were always plenty of rats. On account of the dampness of the soil we used to make our fern or grass beds, if possible, on a bottom layer of dry branches, and we got so accustomed to the rats that we never felt inconvenienced by feeling them running below us through the branches or even over the top of us as we lay in bed. So tame were they that when the candle was lit in the tent they would come peering in at the door or under the curtain looking at you straight in the face with their earnest sharp gaze, and would only go when you shied something at them; they were not long in returning. On more than one occasion I have been present when men awoke with a rat lying right across their throat—we supposed for the sake of the warmth. There has been a great deal of discussion as to whether the rat of those days was the same species as the rat of to-day, or was what has been called the Maori rat. It is impossible now to determine; this much is certain, that people then never thought of it as the same as the home rat, but always spoke of it as the native rat, and there is no doubt the rat of those days was not so ferocious in his habits nor so timid and wild as the rat that abounds now. My own belief is that they were essentially different animals but of course in the absence of any exact information such a belief goes for nothing.

The gradual disappearance of the rat was accompanied by the appearance and gradual increase of the mouse (*Mus musculus*) and it was a common saying that the mice were driving the rats out. It is quite certain that there were no mice in Otago in 1852, but a year or perhaps two years after they were noticed in Dunedin first, having probably been imported in merchandise or in boxes. They increased rapidly and soon spread into the Taieri. Their further progress was marked by distinct stages. For a long time they seemed to be stopped by the Taieri River, as there were plenty so far, but none beyond. After a time they were heard of at Waihola and they then quickly overran the Tokomairiro Plain to the river—then stopped for a short time, when they appeared all over the district to the Clutha River. It was a considerable time before they were known of across that large stream, and for some time longer before the Molyneux Island was touched by them. A good story used to be told in those days about a certain merchant who imported in a vessel called the "Titan" a lot of mouse-traps, but as there were no mice in the country the traps lay on his shelves decidedly bad stock, of use only for small wits to joke about. However, in about one or two years after the mice appeared, and the traps being the only ones in the market sold readily at a premium. Ill natured people used to say that having imported the traps the mice were afterwards brought in order to sell them, but my own belief is that it was only another instance of a far-seeing individual forecasting the wants and necessities of a new country, and providing for them long before any one else would ever think of them! At any rate the story is worth recording now as evidence that mice were not here before the date I have named above.

It must strike many of you as startling to say that only thirty years ago the flaxy hills and hollows which are now covered by the city of Dunedin were the regular hunting grounds of the Maoris and whalers resident at the heads for the wild pig (*Sus scrofa.*) And there are plenty of old settlers still amongst us who have hunted and caught wild pigs within the city boundaries. Even four-and-twenty years ago I have hunted them not far from the Half-way Bush. I remember on one occasion a large party of us went out to the back of Flagstaff Hill and in two days killed about seventy pigs, young and old. In various parts of the country I have seen them in herds of scores at a time, but they soon disappeared whenever the country became settled. I have had in my possession, and seen in the possession of settlers the tusks of very old boars that must have lived for many years where they were obtained, showing clearly that the pigs were not merely surplus stock escaped from the settlers and gone wild but genuine old Maori pigs. In fact the long pointed snout, long legs, and nondescript colours of the true wild pig showed them to be quite a different breed from

the settlers' imported pig. Their flesh, too, tasted quite different from pork, being more like venison than anything else. But pig-hunting, the New Zealand sport of sports, has long become only a tradition of the past.

So, too, the wild dog *(Canis familiaris)* is now unknown. For some years after the settlers arrived here the wild dog was the terror of the flock-master, and the object of his inveterate hostility. The damage sustained by many settlers was very great, and rewards were offered and paid for the destruction of this predatory animal. It was not always or habitually that the wild dog attacked the flocks, for even where there were numbers of them weeks would go past without the loss of any sheep, and this shows that they must have had other means of subsistence which they depended principally upon, and which they must, indeed, have entirely depended upon before the introduction of sheep by the settlers into the country. But when the peculiar wail or howl of the wild dog was heard in the still night air, a sound which I cannot describe to you, but having something peculiarly weird and unearthly about it, quite different from the howl of any ordinary dog, and one which once heard by you could never be forgotten, then the shepherds with their dogs and guns had to turn out and save the defenceless flock. Most exciting accounts were sometimes told of the hunting of these wild dogs, for it was a curious fact that, as a rule, they ran from any tame dog, and that tame dogs, as a rule, would follow and attack them with all their masters' antipathy. Of course there were exceptions; where, for instance, a wild dog happened to be, as sometimes was the case, a pig dog of the bull-terrier breed gone wild from the Maori or whaling settlements. But the bulk of the wild dogs were not domestic animals gone wild, but the true old Maori wild dog. I know that this statement will be questioned by many who have never believed that there were genuine old-identity wild dogs in New Zealand before Europeans brought them here, even though Captain Cook, in his first voyage to New Zealand, p. 184, states :—"In this country there are no quadrupeds but dogs and rats, at least we saw no other, and the rats are so scarce that many of us never saw them. The dogs live with the people who breed them for no other purpose than to eat; there might indeed be quadrupeds that we did not see; but this is not probable because the chief pride of the natives with respect to their dress is in the skins and hair of such animals as they have, and we never saw the skin of any animal about them, but those of dogs and birds." But the fact of their existence is now pretty well settled, first by the fact of actual specimens of two having been shot some years ago at the Wyndham, and their skeletons preserved now in the British Museum, and the skin of one of them in the Colonial Museum, and by the fact of the finding of the remains of a dog in Taranaki some nineteen feet below the surface, as detailed in a paper by

Dr. Hector in the last volume of the "Transactions." And all these specimens agree pretty well in their general characters and "are unlike any other of the many breeds of dog with which we are familiar." At any rate, whatever their breed, there is no doubt that they were invariably the first and most pressing danger which the squatter had to encounter in going out beyond the lines of settlement and taking up new country, into whatever part of the province he happened to go. Now the wild dog is certainly extinct.

But though now saved from this scourge, the runholder has to do battle with a more serious though less ferocious enemy. It is a matter of notoriety the rapidity and universality with which the rabbit *(Lepus cuniculus)* has overspread the province, and the tremendous loss which it is now entailing upon many runholders. Not many years ago there were no rabbits known as wild in the province, and you have only to look to various official documents, including the Report of a Special Commission, appointed by Government to advise on the subject, to be satisfied to what a serious extent they have multiplied. These documents contain full and ample information on the subject, and render it unnecessary for me here to do anything more than merely refer to this as one of the most extensive changes that has taken place in our fauna.

I cannot, however, refrain from expressing an opinion, which I have mentioned more than once before at our meetings, that if our settlers were a little more careful in protecting the weka or native wood-hen, *Ocydromus australis*, they would find in it one of the most effectual checks to the undue increase of the rabbit, mainly, of course, by its entering the breeding burrows and destroying the young.

At the beginning of this paper I proposed to pass on now to the consideration of some marked changes in the flora of the province which have been specially observed by me, and then to have discussed some of the general questions involved in the facts put before you with a view to the elucidation of the lines along which our observations in future ought to be directed, but my narrative has taken more of a popular character than I at first intended, and has already extended to such an undue length that I must leave these for some future time.

Appendix.

Note on the Wild Dog. By W. D. Murison.

It was in the early part of 1858 that I first learned that wild dogs existed in numbers in the interior. I had previously heard of losses of sheep from dogs on the few runs then taken up on the coast, but it was never clearly known that these were occasioned by the animal which we afterwards knew

as the "wild dog." In 1858 my brother and I took up country in the Maniototo Plains, and decided upon stocking it with sheep as soon as possible. We selected the Shag Valley as the route by which to approach the interior, and it took us several months to form a track before our bullock dray could reach the plains. The furthest back settler at that time was Mr. Charles Hopkinson, whose station was on the spot at Waihemo upon which Colonel Kitchener's house is now built. Mr. Hopkinson, who had visited the plains, was of opinion that the wild dogs would be found to be very troublesome to the sheep, and he advised us to get kangaroo dogs for the purpose of keeping them down. These we were fortunate enough to obtain, and they proved of infinite service to us as hunters. In the spring of 1858 we encountered the first wild dog when camped at the Swinburn on the east side of the Maniototo Plains. He was soon brought down by the kangaroos, one of which had tasted dingo blood in Australia. This particular wild dog was yellow in colour, and so was the second we killed, but the bulk of those ultimately destroyed by us were black and white, showing a marked mixture of the collie. The yellow dogs looked like a distinct breed. They were low set with short prick ears, broad forehead, sharp snout, and bushy tail. Indeed, those acquainted with the dingo professed to see little difference between that animal and the New Zealand yellow wild dog. It may be remarked, however, that most of the other dogs we killed, although variously coloured, possessed nearly all the other characteristics of the yellow dog.

The wild dog, of course, at once proved himself to be the natural enemy of the sheep. Fortunately, however, during the two years which marked their presence in the district, we sustained no very great loss from his ravages. This was due partly to the constant watchfulness of the shepherds and to the circumstance of the flocks being depastured on comparatively level country. The wild dogs were generally to be met with in twos or threes; they fed chiefly on quail, ground larks, young ducks, and occasionally on pigs. On one occasion, when riding through the Ida-burn Valley we came across four wild dogs baiting a sow and her litter of young ones in a dry tussocky lagoon. To our annoyance, our own dogs joined in the attack upon the sow, and the wild dogs got away without our getting one of them. We invariably found, however, when hunting the wild dog on a scent that our kangaroos would leave it, if crossed by the fresh scent of a wild pig.

That the yellow dog already referred to is the remnant of a breed which has existed in New Zealand, I think there can be no doubt. In addition to the evidence which has already been brought to bear in proof of this supposition, I may mention that, about twelve years ago, the jaw-bone of a dog was found in an old Maori oven, some few hundred yards from our

homestead, at the foot of Roughridge. The oven must have been pretty old, as it was covered by about a foot of silt, and the bone in question was amongst a quantity of moa bones, fragments of moa egg-shell, and chert flakes. This interesting relic is now in the Colonial Museum at Wellington.

In conclusion, let me add that I have now before me an old note-book containing a record of the dogs killed by our party in our pioneer days. The entries were made at the time. In all we destroyed fifty-two, thirty-one of which were males and twenty-one females. The first was killed at Swinburn on the 28th September, 1858, the last on the banks of the Upper Taieri on the 10th December, 1860. By far the greater number were killed on the Roughridge side of the plains.

Art. XLIV.—*The Dunedin Fish Supply.* By P. Thomson.

[*Read before the Otago Institute, 7th August*, 1877.]

In compliance with the request of the president and members of the Society, when I read the former paper on the subject last August, I now lay before you the result of my observations for the year ending 31st July last. I may state that my information was obtained in the same way as previously, by taking notes of the various fishes exposed for sale in town, in boats at the jetties, enquiries at Port Chalmers, etc.

The local fishing trade may be represented as follows:—During the year eight boats, employing twenty-four men, have been employed in the fishing outside the Heads; while twelve boats, employing twenty-four men, have been engaged in the seine fishing in Otago harbour and the adjoining inlets. This is independent of Stewart Island, where a number of cutters are engaged in the trade.

The supply has been pretty steady all through the year, though occasionally, when a term, more or less long, of stormy weather occurred, a scarcity would be felt. The Southland steamers often fetch to Dunedin a few boxes of fish, mostly blue cod, trumpeter, and moki, which abound in the bays of Stewart Island. In January last three new boats left this port for the trade there; and only the other day a fine new boat of fourteen tons was launched at Port Chalmers for the prosecution of the outside fishing trade.

The complaint of small fish has been made again and again. This is particularly the case with flounders, which are brought to market of a ridiculously small size. Very juvenile red cod are frequently caught by the seiners in large quantities. Some regulation as to the size of fish exposed for sale ought to be speedily made, in order to prevent their complete extermination. All under a certain size, on being caught, should be

returned to the water. In talking this matter over with one of the dealers, with a number of specimens before us, a size of flounder was considered, and in his opinion, in which I quite concurred, all below eight inches in length from snout to tail should be rejected. Fish under this size are really not worth the trouble of cooking. Complaints as to other fishes are not so often made, even the red cod, though caught very small, being available for table use in a smoked state.

This latter mode of preserving fish is pretty generally used both in Dunedin and Port Chalmers, and large quantities of barracouta, ling, moki, trumpeter, blue cod, and red cod are cured and sent up country and to other towns for consumption. Some curing is also done in the southern district. This is a trade that is yet in its infancy, a very extensive market lying open for occupation, both in this and other colonies. The herring is cured extensively at Picton, and sold everywhere as bloaters; and it must be admitted they taste much like the real Yarmouth article. The mullet, which is common in Otago, and sometimes called herring, does not cure so well, as it is generally very fat, and consequently does not keep.

The table given below contains the names of the fishes, and the number of days they were in the market during the year, from 1st August, 1876 to the 31st July, 1877, both inclusive, with the number of days on which there were no fish.

From the figures in the table it will be seen that the supply has been much more steady and liberal than during last year. This is in a measure due to the pretty regular shipments sent up from the Bluff. One or two welled boats have also been at work on the coasts adjacent to Otago Heads. These welled boats bring in moki, trumpeter, and other fishes to the port, and thus keep the market supplied with what used to be considered rare or scarce fishes. With the exception of ling and sole, all the other items in the table show a large increase on last year's returns.

There is one mode of fishing which has as yet received hardly a fair trial in our waters. I refer to trawling—a method which is largely employed in the seas adjacent to the British coasts. Some years ago a vessel was brought over from Melbourne for the purpose, but the scheme was abandoned before a fair trial had been given to it. I am convinced that, were this plan of catching fish properly gone about, a constant supply could be sent in nearly every weather. The vessels being welled could be kept cruising about till a sufficient cargo was got together, when the port could be run for, and the fish disposed of as required. A supply of soles in particular could thus always be depended upon, and there is no doubt that other ground-feeding fishes would be caught in quantity sufficient to make the enterprise pay.

Names of Fishes.		Number of Days in Market.													
Maori or Settlers' Name.	Scientific Name.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Total.	Last Year.
Hapuka, Groper ..	*Oligorus gigas*	—	3	25	23	17	18	16	18	10	12	17	—	159	143
Kahawai, Salmon ..	*Arripis salar*	—	—	—	—	—	1	—	—	—	—	—	—	1	3
Ling	*Genypterus blacoides* ..	2	2	10	6	8	8	5	—	3	10	15	14	83	109
Manga, Barracouta ..	*Thyrsites atun* ..	—	—	13	24	13	16	17	13	6	12	9	—	123	106
Hiku, Frostfish ..	*Lepidopus caudatus* ..	—	1	—	—	—	—	—	—	1	—	—	9	11	2
Moki	*Latris ciliaris* ..	6	6	22	12	5	13	16	10	10	15	6	15	136	82
Kohi, Trumpeter ..	*Latris hecateia* ..	—	7	11	4	1	—	3	4	5	2	2	12	51	9
Pakirikiri, Blue Cod ..	*Percis colias*	12	7	14	3	6	2	6	8	8	19	10	14	119	78
Granite Trout ..	*Haplodactylus meandratus*	—	—	—	—	—	—	—	—	1	1	—	—	2	—
Red Cod ..	*Lotella bacchus* ..	8	14	18	21	17	17	15	17	17	22	24	24	214	111
Kumukumu, Gurnard	*Trigla kumu*	—	—	—	1	—	—	—	—	1	—	—	—	2	—
Haddock	*Gadus australis* ..	—	3	3	—	—	—	3	—	1	—	—	—	10	—
Parrot-fish	*Labrichthys psittacula* ..	3	3	2	—	2	—	—	—	2	—	2	—	14	—
Sandling or Sand-eel..	*Gonorhynchus greyi* ..	4	—	6	2	1	4	14	5	3	7	10	—	56	34
Ihi, Garfish.. ..	*Hemirhamphus intermedius*	—	10	14	1	3	4	5	—	1	—	3	—	41	19
Butterfish (true) ..	*Coridodax pullus* ..	—	—	3	—	—	—	—	—	—	2	—	—	5	—
Spotties, Marare ..	*Labrichthys bothryocosmus*	—	2	11	9	15	15	15	21	14	10	7	9	128	34
Herrings, Makawhiti..	*Agonostoma forsteri* ..	19	16	24	15	18	22	15	21	18	23	24	18	233	159
Herrings (true) ..	*Clupea sagax*	—	—	—	—	—	2	2	—	—	—	—	—	4	—
Whitebait	*Retropinna richardsoni* ..	—	—	—	—	—	—	—	4	1	—	—	—	5	—
Arara, Trevally ..	*Caranx georgianus* ..	11	4	2	4	12	12	17	6	14	21	8	13	124	89
Patiki, Flounder ..	*Rhombosolea monopus* ..	21	18	25	21	20	24	21	24	19	23	22	23	261	201
Sole	*Peltorhamphus n.zealandiæ*	1	5	1	2	—	—	5	—	1	—	2	3	20	30
Skate	*Raia nasuta*	3	4	5	—	2	—	1	—	—	—	—	—	15	13
Days on which there were no fish		4	5	—	1	3	2	2	1	3	1	—	—	22	32

It may not be out of place to give a few remarks upon the months, incidents, weather, and so on.

August was characterized by stormy and irregular weather, which had its effect in reducing the supply of fish; indeed, large fish were out of the market all the month. The only sort that were anything like constant were flounders and mullet. Though the weather was so severe there were no frost-fish brought to town. On the outer beaches they were not infrequent, though not so plentiful as usual. On four days there were no fish, and for several days only a few small flounders were on sale.

During the early half of September stormy weather was the rule, and fish exceedingly scarce; on several days none at all. On the 28th, some very fine trumpeter were brought in from the coasts, of weight up to ten pounds.

October was characterized by better weather, and the supply of fish was pretty steady. The barracouta made their appearance on the 17th, thirteen days earlier than last year, and were at once in large supply. Garfish were very plentiful about the middle of the month. The true butterfish was brought to market on one or two days.

November was an average month, and fish were fairly plentiful. Flounders, however, were scarce all the month. On the 3rd and 28th, several salmon-trout were caught in the harbour.

There was a good deal of wet weather during December, and for a few days at the beginning of the month fish were rather scarce, and many small flounders sent to town. The season allowing, a good many brown trout were on sale.

Through January fish were abundant. On the 15th several dozen of kahawai were brought to market, two days earlier than last year. They were said to have been plentiful outside the heads, but they were never caught again. No king-fish were caught this year. The herring *(Clupea sagax)* was brought to market in good quantity. Some specimens measured eleven inches long, the average were about nine inches long. On the 4th three cutters sailed from port for Stewart Island, to follow the fishing trade there, the produce to be sent to Dunedin.

February was a month of full supply, though the complaint of small flounders was again common. On several days at the middle of the month *Clupea sagax* was again in the market.

During March the town was well supplied. As a novelty a few whitebait formed an item in the supply for some days.

April was a rather stormy month, and there was in consequence a scarcity for some days.

May saw the market pretty regularly supplied. A fair addition was

made by regular shipments of moki, trumpeter, and blue cod by the steamer from the Bluff. Seine fish were in liberal supply.

During June fish were in steady and liberal supply, large fish particularly so. The barracouta disappeared on the 16th, having been on the coast since 17th October.

July has witnessed a good supply of fish. Ling of large size were plentiful, as were also red cod and mullet; a quantity of the cod were cured by smoking. Trevally were also very plentiful for several days.

Regarding the fishes themselves I give the following notes:—

1. Groper.—Excepting during the month of July and August, this excellent fish has been pretty constantly in the market. A few very large individuals were brought to town, weighing as high as fifty to sixty pounds, but from twenty to thirty pounds is the average size. Was in the market altogether 159 days, as against 143 last year.

2. The kahawai was only in the market on one day, in January, when upwards of forty were brought to town. They were said to be plentiful outside the Heads at the time, but they had all disappeared by next day.

No kingfish visited the coast this year.

3. Ling is present in the market more or less all the year round, save about the autumn, when it is generally scarce. This is among the best of our food fishes, and is sometimes of large size, up to twenty pounds. The young of the ling are sometimes caught by the seiners, and are very pretty, being curiously spotted. This fish was present 88 days and last year 109.

4. Barracouta were in large, though somewhat irregular supply, during the season, which began on the 17th October, about a fortnight earlier than usual. They were plentiful in the open water all along the coast. Were in the market 123 days, for 106 during last year.

5. Frost-fish have been scarce until the middle of July, when during some fine clear *frosty* weather, with a young moon, they were for a few days quite plentiful, some of the shops having from three or four up to twenty; nearly seventy were caught in one day at or near Purakanui. They were brought to market on eleven days. Settlers along the seaboard to the north have caught them pretty frequently. No further light has been thrown on the singular habits of this fish.

6. Moki is now a much more regular visitor to our market than in former years. Independent of the supply from our local fishermen, moki are brought by the Southland steamers from the Bluff, to which they are brought by the Stewart Island fishermen and shipped to Dunedin. This fish was in the market 136 days, against 82 last year.

7. Trumpeter has also been in increased supply, principally from the south. Was in the market on 51 days, 0 last year.

8. Blue cod has been pretty constantly in the market, coming also

largely from Stewart Island. It is also to be had off any of the rocky points near the Heads. Was in the market 119 days, and 78 days last year.

9. The granite trout, though not a trout at all, is yet a very good fish, but only occasionally brought to market.

10. Red cod is perhaps the most plentiful of all our finny visitors, and is caught in large numbers, both inside and outside the Heads. Both large and small fish are cured by smoking, and sold as Finnan haddock, which they resemble very much, but far too many small ones are caught. They were in the market 214 days, against 111 for last year.

11. The gurnard is only an occasional visitor to our market, and can hardly be reckoned on as a regular food-fish.

12. The haddock is caught occasionally, but there are seldom more than two or three got at a time.

13. Parrot-fish were in the market on about fourteen days during the year.

14. The sandling or sand-eel is a very delicate fish, and is often in the market. It is not, however, very plentiful, and is irregular; was in the market 56 days, last year 84 days.

15. The garfish was very plentiful during the summer months, and is sometimes present in the town harbour in immense shoals; was in the market on 19 days last year, on 41 this year.

16. The true butterfish was caught several times during the year. It must, however, be considered as a very rare fish in our waters.

17. The spotty, or butterfish of our local fishermen, has been very plentiful this year, and has been brought to town in large numbers at times; was in the market 128 days, as against 84 for last year.

18. The herring or mullet is a very abundant fish in Otago harbour, and furnishes very good sport with a rod and line. It varies in size from six to fourteen inches in length. It is one of the best of our fishes, and was in the market 238 days, for 159 last year.

19. The true herring was brought to market on one or two days during the summer. This is a migratory fish, and does not stay on the coast more than a few days in the year, when it is present in immense shoals. Those brought to town varied from seven to eleven inches in length.

20. Whitebait were on sale for a few days in autumn. I think these are the young of more than one fish, perhaps both mullet and herring. They are caught in one or two places in the harbour, at the mouth of the Leith in Pelichet Bay, and in the steam basin.

21. That excellent fish the trevally was almost constantly in the market during the year. About midsummer some very large specimens were on sale; was present on 124 days, and 89 last year.

22. Flounders were in regular supply all the year. It is much to be regretted that the fishermen will persist in sending so many small ones to market, legislative interference will have to take place. But there would be no need for it if fishermen would only use their common sense and reject all below a certain size. The dealers would also help materially if they refused to buy small fish. The flounder was in the market 261 days, for 201 last year.

23. Soles are somewhat rare in our market, and are most plentiful in spring. Two varieties appear to be caught here, differing but slightly from each other; were thirty days in the market last year, and twenty this year.

24. The skate is not often brought to market, but is not a scarce fish, and as a food-fish has few superiors; was fifteen days in the market, against thirteen last year.

Some odd fishes now and then turn up in the market, such as the Maori chief, cat-fish, silver-fish, etc., but of these there is seldom more than one at a time, and so I omitted them from the table. There is also the common leather-jacket or pig-fish of our harbour (*Agriopus leucopoecilus*) which is often caught, but very seldom offered for sale, though good eating. One schnapper was caught late in the season.

In conclusion, I have only to add that a great deal of pain and trouble have been used in order that the information may be as correct as possible; and when I state that the table is the result of nearly 4,000 entries, you will see that I have gone with some minuteness into my task.

During the year there were twenty-two days on which there were no fish on sale; during last year there were thirty-two such days.

ART. XLV.—*Notes on the Whales of the New Zealand Seas.*

By JAMES HECTOR, C.M.G., M.D., F.R.S.

Plates XVI. and XVII.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

HAVING lately had an opportunity of examining various type specimens of our Cetaceans in the European museums, and of consulting important books of reference on this branch of our zoology, especially the magnificent work of Professors Van Beneden and Gervais,* I am enabled to offer a few critical notes on some of the species in continuation of my former papers to the Society,† and in anticipation of a complete review of the species now described from New Zealand, showing the present state of our knowledge on this subject.

1. NEOBALÆNA MARGINATA.

> *Neobalæna marginata*, Gray; Supp. Cat. Seals and Whales, p. 41; Hector, Trans. N.Z. Inst., II., 26, (skull); V., pl. 6 (ear-bones); VII., 251, pl. 17 (external form and complete skeleton).

This species having by one author‡ been treated as a synonym of *Eubalæna australis*, or the black whale, I have compared the skeletons of young individuals, as I presume that, from its small size, it has been taken for the young of the latter species.

Only three examples of *Neobalæna* are known:—

a. The original type from Kawau Island, presented to the Colonial Museum by Sir George Grey, and of which only the skull was preserved, measuring 57 § inches in length. This is the largest specimen yet met with, and the proportionate length of the animal would be 20 feet.

b. A complete skeleton 14 feet 6 inches long, obtained ||by Mr. Charles Traill on Stewart Island, and now in the British Museum, and of which the skull measures 41 inches.

c. Skull of a very young individual in the Auckland Museum, measuring 35 inches.¶

In each of these specimens the baleen is present with the characteristic elongated form, fine texture, and yellow colour with a black margin, and the other details of the skull and form of the ear-bones also agree closely, exhibiting only differences of growth.

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* Ostéographie des Cétacés vivants et fossiles: 4to., with atlas of plates, folio. Paris. 13 parts published.

† Trans. N.Z. Institute, II., 26; III., 128; V., 154; VI., 86; VII., 251; IX., 477.

‡ A. W. Scott, M.A., Mammalia, recent and extinct—Section PINNATA. Sydney, 1873.

§ Trans. N.Z. Inst., II., 26. || Trans. N.Z. Inst., VII., 253.

¶ Trans. N.Z. Inst., VII., 251.

With the last-mentioned specimen I was able to compare the skull of a young calf of *Eubalæna australis*, the complete skeleton being in the College of Surgeons Museum, London, and 12 feet in total length, the skull measuring 36 inches, and the difference in the cranial characters of the two species is found to be quite as obvious as in the more fully developed skulls. The general outline of the two skulls at once distinguishes them. In *Neobalæna* the greatest width is across the hinder border which is also concave in outline, owing to the projection backwards and outwards of the exoccipitals and squamosals, whereas in *Eubalæna* the greatest width is across the orbital plates of the frontals, so that the posterior half of the skull is convex in outline.

In *Neobalæna* the skull is less arched, the length being four times the height of the arch between the glenoid processes and the tip of the beak, and the supra-occipital is a narrow bone with a strong median ridge extending forwards for half the total length of the skull; but in the young *Eubalæna* the height is equal to two-fifths the length, and the supra-occipital has a circular outline, is flat, and extends over only one-fourth of the arch of the skull.

It is obvious that even at the earliest age these crania present marked differences, while the divergence exhibited in the other osteological characters is still more striking. Thus comparing the complete skeleton of *Neobalæna*, 14 feet 6 inches in length, with *Eubalæna*, we have—

	Neobalæna.	*Eubalæna.*
Cervicals	7	7
Dorsals	15	15
Lumbars	6	12
Caudals (with chevrons)	6	10
,, (without chevrons)	10	15
	44	59

In *Neobalæna* the scapula is nearly twice as wide as high with strong coracoid and acromion processes, almost as in *Balænoptera*. In *Eubalæna*, on the contrary, the scapula is high and narrow and with only one feeble process. In the form of the vertebræ, sternal apparatus, and especially in the quality and proportional dimensions of the baleen, *Neobalæna* has some affinity with the right-whale (*Mysticete*) of the Arctic Seas, and it is not unlikely that it may be a species abounding in the unexplored seas of far southern latitudes, where it may attain to a large size, only stragglers occasionally reaching to the latitude of New Zealand and Australia. In these seas the normal representative of the *Balænidæ* is *Eubalæna australis*, just as in the northern hemisphere *Eubalæna biscayensis* in the temperate latitudes of the Atlantic, and *E. japonica*, of the Pacific, replace the *Mysticete* of the

Arctic regions. If such be the case it will have an interesting bearing on the distribution of the Cetacea, that the forms of temperate latitudes (*Eubalæna*) should present less divergent characters than the Arctic and Antarctic representative forms.

2. EUBALÆNA AUSTRALIS.

Balæna australis, Desmoulins; Dict. Class. H.N., II., 161.

Balæna antipodarum, Gray; Dieffenbach's N.Z., II., 183; v. Beneden and Gervais, Ostéog., 85.

Caperea antipodarum, Gray; Cat. S. and W., 101.

Hunterius temminckii, Gray; l.c. 98.

Macleayius australiensis, Gray; Trans. N.Z. Inst., VI., 90.

Eubalæna australis, Gray; Cat. S. and W., 91 (as a Cape species); Hector, Trans. N.Z. Inst., V., 156 (as a New Zealand species).

Examination of the type specimens of the foregoing species, into which the common black whales of the southern seas have been divided, confirms the view that there are no sufficient grounds for their separation, and that they should be combined under the name first given to Cuvier's "*Baleine du Cap.*"

At the same time I adopt Gray's separation of the genera *Balæna* and *Eubalæna* as necessary on account of the great difference in the form of the skull, in the number of ribs, and the quality and size of the baleen. Thus in *Balæna* the head is one-third of the entire length of the animal, and the maxillaries are enormously produced, so that they are three-fourths of the length of the skull.

In *Eubalæna* the head forms one-fourth of the length, and the beak is only two-thirds the length of the skull.

The number of vertebræ compare as follows:—

	Balæna.	*Eubalæna.*
Cervicals	7	7
Dorsals	13	15
Lumbars	10	10
Caudals	23	27

Although the fine skeleton of *Balæna mysticetus* in the Brussels Museum shows a rudimentary fourteenth rib on the left side, the number of dorsal vertebræ in that species never exceeds thirteen, while fifteen is the constant number present in *Eubalæna*.

Balæna antipodarum was the name given by Gray to a whale of which only a sketch was preserved, taken by Major Heaphy, V.C., from a specimen stranded in Jackson Bay, Tory Channel, in 1839,* and the same name has been given to a fine skeleton in the Museum at Paris, obtained in Akaroa Harbour by Captain Berard and Dr. Arnoux of the French corvette "Le Rhin." The length of this skeleton is 45 feet, the skull being 13 feet, and

* Dieffenbach's New Zealand, I., 44.

in the same museum is the type specimen of *Eubalæna australis*, from the Cape of Good Hope, which is 49 feet in length, the skull measuring 14½ feet. In both skeletons the number of dorsal and lumbar vertebræ is the same, but in the former only nine caudal vertebræ have chevron bones and twelve are without, while in *Balæna australis* thirteen have chevron bones and there are twelve without, thus having four more caudal segments than in the New Zealand specimen; but as the few other divergent characters of the two skeletons are within the limits of individual variation, it is probable that the above difference is due to the imperfection of the shorter skeleton, some of the chevron bones and terminal ossicles having been lost.

The other differences are stated by Van Beneden and Gervais to be as follows:—*

The mandible has a smaller coronoid process but has a better developed articular surface in *B. australis*, and the superior maxillary bone is stronger, and the temporal bone notably more massive. In *B. antipodarum* the beak is a little more curved. There is also a slight difference in the size of the arm bones, and the acromion process of the scapula, present in *B. australis*, is represented only by a tubercle or ridge in the other skeleton.

This latter character cannot, however, be considered as important, for in the same museum is the skeleton of another whale (*Megaptera lalandii*) in which the scapulæ of the opposite sides differ in this respect. After examining the skeletons referred to, and being familiar with the variations presented among the bones of the same species scattered about the whaling stations on the New Zealand coast, I do not attach much importance to these distinctions, but at the same time it must be noted that in the skeleton of a black whale obtained on the coast of Canterbury by Dr. von Haast, and now mounted in the British Museum as the type of *Macleayius australiensis*, Gray, the total number of vertebræ is also 54. The strong curvature which has been given to the vertebral column in mounting this fine skeleton, gives it, at first sight, a very different aspect from the Paris specimens, but closer examination proves it to agree closely in all characters but the number of terminal caudal ossicles, with *Eubalæna australis*.

In the Dunedin Museum, the skeleton of a young black whale obtained on the Otago coast, has been mounted by Professor Hutton, and he informs me that in this specimen also the number of vertebral segments is 54.

The smaller number of vertebræ thus appears constant in the only three complete skeletons of the New Zealand *Eubalæna* which are available; whereas in the skeleton of the Cape *Eubalæna*, of which there are two in Paris, old and young, one young at Leyden, and one, also young, in the

* *Loc. cit.*, p. 53.

College of Surgeons Museum, London, the number varies from 56 to 59. But Cuvier's original description of the Cape whale gives the number of vertebræ as 49, with 14 chevron bones;* and it is probable that the number of rudimentary tail bones is unimportant, as they are very likely overlooked in some cases, and left enclosed in the tough caudal integument when the skeleton is being stripped.

As the whalers only recognize one kind of black whale, which is common throughout all southern seas, and there is no difference in habits, food, or distribution in latitude observable among them, it does not seem necessary in the present state of our knowledge that the New Zealand and the Cape species should be considered as different.

NOTE.—27th Feb. Since writing the above, I have had an opportunity of visiting the Otago Museum, and I find that the skeleton of *E. australis* above referred to is evidently incomplete, and that the number of vertebræ is not to be taken as a reliable character.

MEASUREMENTS.	Ft.	In.
Total length	29	1
Length of skull	7	8
Width, orbital	5	6
,, exoccipital	2	6
Height of arch of skull	3	4

The vertebral column as mounted consists of—Cervical, 7; dorsal, 15; lumbar, 10; and caudal, 22; but the latter region is imperfect, and is partially restored artificially.

The condition of the cervical region is interesting. The first to the fifth segments are united by the spinous processes and laminæ; and the third and fourth, on the left side only, by the tips of the inferior lateral processes. Otherwise the vertebræ are distinct.

Only 14 pairs of ribs have been mounted, but, as they are not in relative position, the number is probably also erroneous, and should, from the appearance of the vertebræ, be 15 on each side.

Only a few of the chevrons are present, but, to judge from the presence of facets for their attachment to the centra, they were 13 in number, being attached from the 33rd to the 46th vertebræ. The 39th to the 45th have the lateral processes perforated, but the characters of the caudal region are not reliable.

The scapula agrees with that of *E. australis* in the Paris Museum, and not with *E. antipodarum*, in having a well-developed acromion process.

In the same museum is a skull and the scapula of another specimen of this whale, but of much larger dimensions, which agree in their characters with the foregoing.

8. MEGAPTERA LALANDII.

Megaptera lalandii, Fischer; v. Beneden and Gervais, Ostéog., 133.

Poescopia lalandii, Gray; Cat. S. and W., 126.

Megaptera novæ-zealandiæ, Gray, Cat. S. and W., 128; Hector, Trans. N.Z. Inst., V. 156, VII., 255.

Although the humpback is the most common whale round our coasts, a complete skeleton of a New Zealand specimen is still a desideratum. From

* Gray, Cat. S. and W., p. 92.

the comparison of the skulls described in my former paper, one of which is now in the British Museum and the other in the Colonial Museum, with the type from the Cape of Good Hope in the Paris Museum, which is described and partly figured by Van Beneden and Gervais, I feel no hesitation in identifying the New Zealand humpback with that from the Cape.

4. Physalus australis.

Physalus australis, Desmoulins; Dict. Class. H.N., II., 166.
Balænoptera australis, Gray; Zool. Er. and Terr., pl. 51.
Sibbaldius antarcticus, Gray; Cat. S. and W., 381.
Balænoptera antarctica, v. Beneden and Gervais, Ostéog., 234.
? *Physalus grayi*, McCoy; Zool. and Palæont. of Victoria, p. 4.
? *Sibbaldius sulphureus*, Cope; Proc. Phil. Acad., 1869, 20.
Stenobalæna xanthogaster, Gray; Ann. and Mag. N.H., 1874, 305.
Physalus australis, Hector; Trans. N.Z. Inst., V., 157, VII., 257.

The complete skeleton, seventy feet in length, of the great southern rorqual described in my former paper* has now been mounted in the Colonial Museum, and there are no osteological characters by which it can be distinguished from the great northern rorqual (*Physalus antiquorum*, Gray, or *Balænoptera musculus*, Van Beneden and Gervais) of which I have examined skeletons in the museums at London, Edinburgh, and Turin.

In its external characters, and especially in having a small dorsal lobe situated far back, instead of the high erect fin so characteristic of the northern *Physalus*, it resembles the broad-nosed fin-whale (*Physalus sibbaldii*) figured by Turner,† but the short pectoral limbs, the form of the skull, and the number of vertebræ, 64,‡ its fifteen ribs and great size readily distinguish it from the genus *Sibbaldius* of the rorquals, which have 56 vertebræ and fourteen ribs and expanded maxillaries.

As there is no other complete skeleton of the southern rorqual yet described, and the various species above quoted from the South Seas and the Pacific Ocean have been founded on very fragmentary evidence, I think it better to combine them under the name by which the razorback was first recognized in the south.

The specimen in the Melbourne Museum, quoted from Professor McCoy, appears to be the same, but it is not yet fully described, the chief point of difference noted being that it has 16 and not 15 ribs, which is the number in other skeletons of the species.

Sibbaldius sulphureus, Cope, is only named from descriptions and drawings, and I have suggested it as probably the same as the southern species, on account of the resemblance of a skeleton which I obtained in San

* Trans. N.Z. Inst., 1875, VII., 257. † Trans. R. Soc. Ed., XXVI., 197.

‡ By an oversight the number of vertebræ was formerly given as 57, the seven cervicals not having been included. "Trans. N.Z. Inst.," VII., 259.

Francisco, and which I have reason to think was that of the whale referred to in Professor Cope's description; but only a very cursory examination could be made of this skeleton while I was packing it for transmission to the British Museum, where it is now deposited.

5.—BALÆNOPTERA HUTTONI.

Balænoptera huttoni, Gray; Ann. and Mag. Nat. Hist., XIII., 450.
Physalus antarcticus, Hutton; Ann. and Mag. Nat. Hist., XIII., 316.

This is the pike whale of the southern seas and is hardly distinguishable from the northern *Balænoptera rostrata*. The genus *Balænoptera* is here restricted to the small rorquals, which have less than 50 vertebræ and 11 pairs of ribs. The type of *B. huttoni* is in the British Museum, but was not mounted when I examined it. The second and third cervicals show marks of adhesion, and specimens of these vertebræ in the Colonial Museum are as firmly anchylosed as in *B. rostrata*.

6. PHYSETER MACROCEPHALUS, Linn.

Catodon australis, Gray; Cat. S. and W., 206; Hector, Trans. N.Z. Inst., V., 158.
Meganeuron krefftii, Gray; Cat. S. and W., 387.
Catodon colneti, Gray; Cat. Cetac. B.M., 52.
Physeter polycyphus, Q. and G.; Uran. Mamm., t. 12.

The sperm whale is ubiquitous in warm seas and occasionally roams into high temperate latitudes. It is represented in almost every museum by fragmentary or complete skeletons presenting variations due to age, but there appears to be no ground for distinguishing more than one species which has the name originally given by Linnæus.

7. KOGIA BREVICEPS.

Physeter breviceps, De Blainville; Ann. d'Anat. et de Physiol., 1838, II., 337.
Kogia breviceps, Gray; Cat. B. M. Cetacea, 1850, p. 53.
Physeter simus, Owen; Trans. Zool. Soc., VI., 30.
Euphysetes grayi, Macleay; Gray, Supp. Cat. S. and W., 392.
Kogia macleayi, Gray; Cat. S. and W., 218.
Euphysetes macleayi, Krefft; Proc. Zool. Soc., 1865.
Euphysetes pottsii, Haast; Trans. N.Z. Inst., VI., 97.
? *Kogia floweri*, Gill; Amer. Nat., IV., 738.

This very remarkable and diminutive form of the *Physeteridæ* has probably a similar range to the sperm whale, but only one instance is recorded of its occurrence north of the equator. Professor Gill describes a specimen from Mazatlan on the coast of Mexico, which is probably the same species. The other specimens have been taken in the seas off the Cape, Australia, and New Zealand, and there does not appear to be any reason for making several distinct species, as the only complete skeletons agree in all essential characters.

8. Berardius arnuxii, *Duvernoy*.

Plate XVI.

An adult male of the porpoise whale was captured in the entrance to Wellington Harbour on 12th January, 1877, and the complete skeleton has since been mounted in the museum.

The condition of the terminal epiphyses of the vertebræ and limb bones shows it to be of more mature age than the specimen of slightly larger size forwarded to the College of Surgeons Museum by Dr. von Haast, in 1868,* which Prof. Flower has made the subject of a most exhaustive and masterly memoir.† The external form of this whale is shown in the accompanying outline sketch (plate XVI.) which was made by careful measurement. The colour was black with a purple hue, except a narrow band along the belly, which was grey. The muzzle, flippers, and tail lobes were intensely black. The snout was flattened above and the lower jaw projected two inches beyond the upper, which was received into firm fleshy lips. The interior of the mouth was of a dark slate colour. The teeth did not penetrate the gums, nor could their position be discovered till deep incisions were made.

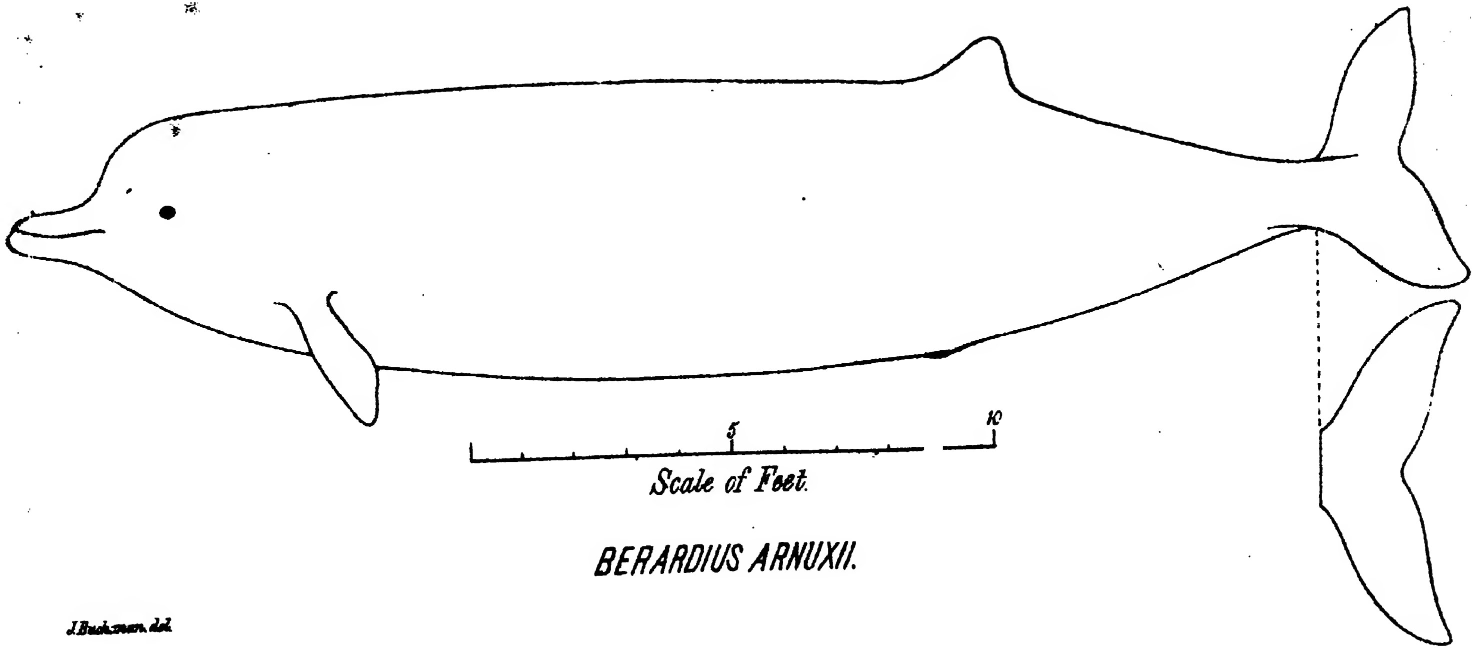
The blow-hole was on the vertex of the head directly over the eye, with a rounded protuberance in front. The flippers were stout and rigid, and there were no axillary folds of skin to indicate great freedom of motion.

The form of the body was cylindrical and of nearly uniform size between the flippers and the vent. The dorsal fin, which commenced over the vent, was thick and rigid with a thin rounded edge. The tail lobes were broad and powerful.

	Ft.	In.
Total length	27	6
Extreme girth at middle	15	0
Snout to eye	2	11
Snout to blow-hole	3	6
Length of gape	1	8
Anterior border of flipper	2	7
Snout to root of flipper	5	2
Snout to dorsal fin	18	0
Length of base of dorsal fin	2	0
Height of dorsal fin	0	10
Expanse of caudal flukes	5	3

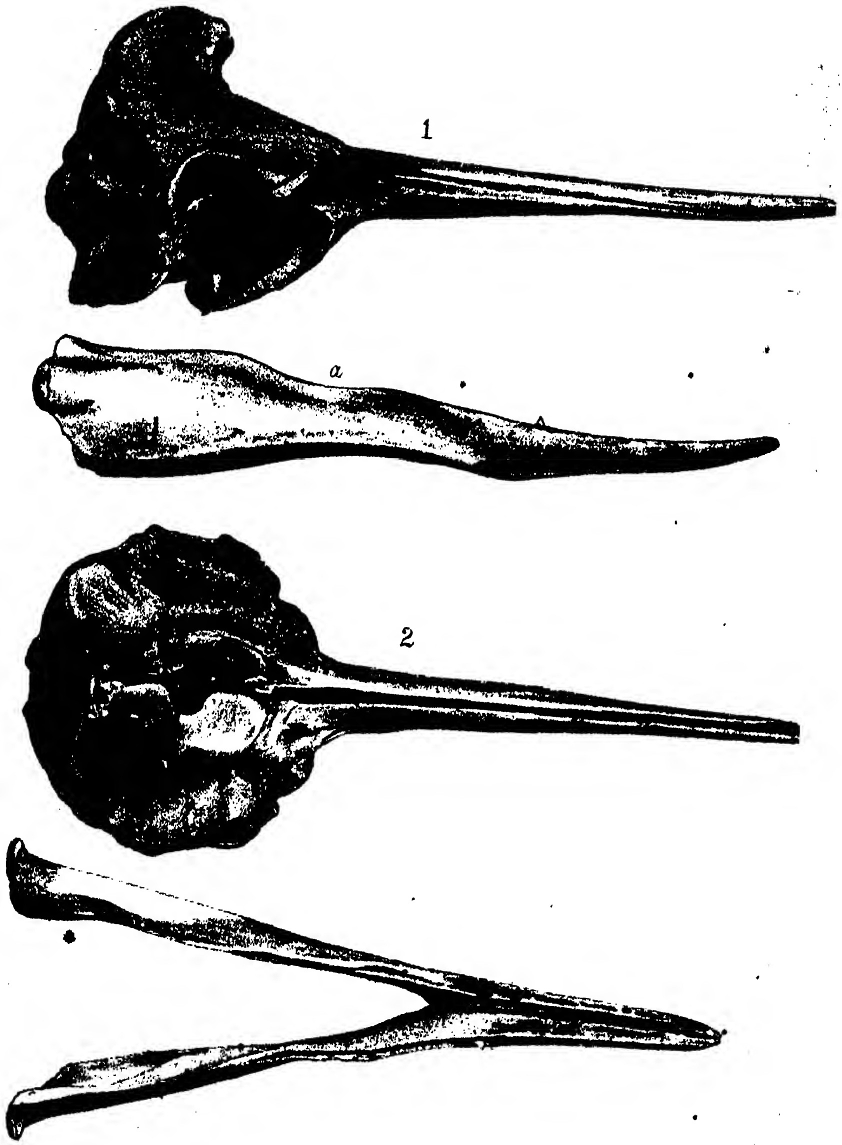
The skeleton agrees in most of the details with that described by Prof. Flower. The teeth are two on each side near the tip of the lower jaw, the anterior being the larger, and agreeing in form with the single tooth found on each side of the jaw of the specimen captured at the same place in January, 1870.‡ The skull of that specimen is in the museum, and agrees in every

* Trans. N.Z. Inst., II., 190. † Trans. Zool. Soc., VIII., 203.
‡ Trans. N.Z. Inst., III., 129.



BERARDIUS ARNUXII.

J. Buchanan, del.



MESOPLODON HECTORI.

J.B. lith.

respect with the one under consideration, so that there is no doubt that the presence or absence or relative position of the rudimentary teeth in the ziphioid whales is a matter of no specific value, contrary to the assertion of Dr. von Haast.*

The three first cervicals only are anchylosed, as described by Prof. Flower, but the neural arches of the posterior cervicals are complete and not open, which is one point of difference between the two skeletons.

The total number of vertebræ is 47, or one less than in the College of Surgeons specimen, and yet extreme care was taken to secure the whole of the small tail bones. There is also a slight difference in the number of vertebræ in the regions of the spinal column, as described by Prof. Flower, from the skeleton now in the Colonial Museum, thus:—

	FLOWER.	COL. MUS.
Cervicals	7	7
Dorsals	10 †	10
Lumbars	12	13
Caudals with facets for chevrons	12	10
Tail proper	7	7

Only the six last chevron bones were present, being attached to the 36th–42nd vertebræ, and although the four preceding vertebræ, 31st–35th, have distinct hæmal facets, none of the corresponding bony arches were present. It is useful to note such discrepancies, as showing the amount of individual variation which may exist in the same species.

The number of phalanges in the digits of the manus, which Prof. Flower suggests were imperfect in his specimen, are in my specimen I.–1, II.–6, III.–5, IV.–4, V.–3.

9. MESOPLODON HECTORI.

Mesoplodon hectori, Gray; Ann. and Mag. Nat. Hist., VIII., 117.

Plate XVII.

It is very doubtful if this species should be separated from *M. sowerbyi*, De Blainville, which seems to be subject to great variation in the position and development of the mandibular teeth, the length and basal width of the beak of the skull, and the presence or absence of a meso-rostral callosity. There appear, however, to be two extreme forms in the New Zealand seas, one representing the type of *M. sowerbyi*, of which the skull in the Canterbury Museum, which I formerly described as a variety of *M. hectori*,‡ is probably an instance; but a still more extreme form in the same direction of development is found in a skull in the Otago Museum, of which I am

* Trans. N.Z. Inst., IX., 455.

† Twelve thoracic vertebræ are mentioned in the text, though elsewhere described as ten, l. c., p. 226.

‡ Trans. N.Z. Inst., V., 168.

able to give a figure (plate XVII.) from a photograph which I had taken by permission of Prof. Hutton. The other group, of which the type of *M. hectori* is an extreme though very young example, represents the forms similar to *M. europæus* of the northern seas.

These extreme forms are separated, but with many intermediate examples, chiefly on account of the position and size of the tooth in the mandible, a character to which I think too much importance has been attached, as no two specimens yet obtained agree perfectly in this respect.

The complete skeleton of an adult male of *M. hectori* which I obtained in Lyall Bay, near Wellington, in January, 1875,* agreed perfectly with those parts which had been preserved by the late Dr. Knox of the type of the species from Tetai Bay, Porirua Harbour, but in this second case the teeth were situated several inches from the tip of the mandible, while in the type they were at the extreme tip, though still lateral and not terminal as in *Ziphius*.†

Again, in the very young specimen of which I obtained only the lower jaw from Kaikoura, the teeth were opposite the hinder edge of the symphysis.‡

Dr. von Haast has lately described under a new genus *Oulodon*§ three specimens obtained by Mr. Hood in the Chatham Islands of a *Mesoplodon*, which has a row of small teeth in the upper jaw, in a position corresponding to the shallow emargination of the upper part of the ramus of the mandible of the Otago Museum skull (*a*. fig. 1, pl. XVII). No anatomical description of *Oulodon* has yet been published, and as the characters of the skulls figured and described by Dr. von Haast were concealed by the dried integument, its exact affinity to the other species of *Mesoplodon* cannot be detected; but, while the longest of the skulls (No. 1) has the mandible produced to three times the width between the articulations (computed from the orbital width which is given by Dr. von Haast) and the teeth at one-third the length of the mandible from the tip, in both of which characters it again agrees with the Otago Museum skull, the shorter skull (No. 3) has the length of the mandible only twice the articular width, and the tooth at one-fourth the length of the mandible from the tip, thus approaching *M. hectori* in its proportions.

The presence of rudimentary teeth in the upper jaw of *Mesoplodon* is certainly a most interesting discovery, but the animals have so seldom been examined in the flesh that it may not prove to be of uncommon occurrence, although it has escaped the notice of all naturalists prior to Dr. von Haast.

* Trans. N.Z. Inst., VII., 262.
† Trans. N.Z. Inst., III., pl. 14, 15.
‡ Trans. N.Z. Inst., VI., pl. 15a.
§ Trans. N.Z. Inst., IX., Art. LVI.

Similar teeth in the gum of the upper jaw have, however, been previously recorded for the closely-allied *Ziphius cavirostris;* but, as Professor Turner remarks in describing a skull of this species found in Shetland, "such teeth are quite rudimentary and functionless, and the presence or absence of such aborted organs ought no more to form the basis for establishing a specific difference, than should the entire absence of teeth both in the upper and lower jaw of the Shetland cranium be a reason for regarding it as a distinct species."*

10. MESOPLODON LAYARDI.

Dolichodon layardi, Gray; Cat. S. and W., 353; Hector, Tr. N.Z. Inst., V., 166.
Dolichodon traversi, Gray; Trans. N.Z. Inst., V., 96.
Mesoplodon layardi, Flower; Nature, VII., 368.
Mesoplodon floweri, v. Haast; Trans. N.Z. Inst., IX., 442.

Only five or six examples of this curious and generally supposed abnormal form of ziphioid have yet been met with, and of these I have seen four, (1) a lower jaw from the Cape of Good Hope, collected by the Challenger Expedition, (2) a lower jaw I have already described from the Chatham Islands,† (3) the complete skeleton in the Canterbury Museum, a very complete anatomical description of which has been given by Dr. von Haast,‡ and (4) the skeleton in the Sydney Museum, which has been made the type of a new species, *Mesoplodon güntheri*, Krefft, but which Professor Flower considers to belong to the species now under review.§

In the last specimen the teeth are not so fully developed into the wonderful strap-shaped arches as in the type, but they are evidently intermediate in their form between it and the triangular tooth of *M. sowerbyi.* This skeleton has not been yet described, I believe, but Mr. Scott states || that he has compared it with the drawings of the skeleton of *M. sowerbyi* given by Van Beneden and Gervais, and cannot detect any essential difference of structure between them. The other species I have seen, although each has received a different specific name, are only distinguished by a slight divergence in the form of the mandible, and the manner in which the large abnormal tooth or rather *tusk* has been bent or worn, which characters are obviously due to individual variation.

The skeleton described by Dr. von Haast is of a mature and probably an aged animal, and as the other specimens that have large tusks correspond in size, and the osteology in most points agrees with other Mesoplodonts, it is not improbable that it may be only the aged condition of some species already known from immature individuals. Dr. von Haast states

* Trans. Roy. Soc. Edin., XXVI., 769.

† Trans. N.Z. Institute, V., 166. ‡ Trans. N.Z. Inst., IX., Art. LV.

§ Nature, VII., 368. || Mamm. Recent and Extinct, p. 116.

that it is the only ziphioid whale that has three cervical vertebræ anchylosed and four separate ;* but *Berardius* has this character, and the two skeletons of *M. hectori* differed in this respect, one having two and the other four vertebræ anchylosed.

Although it is most probable that the hypertrophy of the teeth in this species is only analogous to the overgrown tusks occasionally met with in wild boars, it may be as well for the present to treat it as a character of specific value until further information is obtained about this whale in its earlier stages of growth.

As an aid to the comparison of the various forms comprised in this most puzzling genus *Mesoplodon*, I have compiled the following table of measurements from the various sources at command :—

	A.	B.	C.	D.	E.	F.	G.	H.	I.	K.	L.
Length of skull ..	28·0	30·0	23·5	29·5	31·0	36·5	37·0 ?	35·0 ?	24·0 ?	41·7	..
" of cranium	11·5	12·0	8·5	10·5	13·0	13·5	14·5	13·5	9·0	15·7	..
" of beak ..	17·5	18·0	15·0	19·0	18·0	23·0	22·5	21·5	15·0	26·0	..
" of mandible	24·5	25·5	19·0	25·5	..	34·0	31·0	30·0	19·0	34·7	32·0
" of symphyses	7·0	5·2	6·0	6·0	..	14·0	11·0 ?	10·0 ?	5·0 ?	8·0	10·0
Frontal width ..	12·0	12·5	9·5	11·0	11·0	14·0	12·0	12·0	9·5	15·0	15·0 ?
Distance of tooth from tip of mandible ..	8·0	8·0	1·0	4·0	..	11·0	10·5	10·0	5·0	8·7	11·5

A.—*Mesoplodon sowerbyi*, Van Beneden.
B.—*M. europæus*, Van Beneden.
C.—*M. hectori*, Tetai Bay, Colonial Museum.
D.— " Lyall Bay, "
E.—Skull in Canterbury Museum, no mandible.
F.—Skull in Otago Museum (Pl. XVII).
G.—*Oulodon*, No. I., v. Haast.
H.— " No. II., "
I. — " No. III., "
} In these the total length has been estimated from the other proportions.
K.—*Mesoplodon floweri*, Haast.
L.—*M. layardi*, Chatham Islands, Colonial Museum. Breadth computed from distances between articular surfaces.

11. Ziphius cavirostris, *Cuvier*.

Epiodon chathamiensis, Hector ; Trans. N.Z. Inst., V., 164.

Epiodon novæ-zealandiæ, v. Haast ; Trans. N.Z. Inst., IX., 430.

Dr. von Haast has given an elaborate description of the second complete skeleton of this whale yet obtained, the first, which is in the museum at

* *Loc. cit.*, 446.

Buenos Ayres, having been described in detail by Burmeister as *Epiodon australe.*

In European museums this whale is only represented by skulls, the individual specimens of which have generally been distinguished by specific and even generic appellations; but it has been shown by Prof. Turner, of Edinburgh University, in a memoir reviewing the whole subject,* that the distinctions are only founded on changes and developments of the meso-ethmoid cartilage, which with increasing age becomes ossified and swollen into different shapes, while at the same time the bony processes surrounding the præ-nasal fossa also undergo change of form; but these differences he considers do not exceed the range of individual variation which is often met with in comparing a series of crania of the same species of animal.

He further shows that the geographical range of *Ziphius cavirostris,* including all known forms, is equal to that of the sperm whale, of which one species only is now generally admitted to exist.

The specific distinction made by Dr. von Haast between the Chatham Island and New Zealand specimens is founded on little more than the form of the teeth, which in the latter specimen, now in the Canterbury Museum, I have formerly pointed out had become absorbed,† only the fangs being left, while in the slightly smaller and probably younger specimen from the Chatham Islands the teeth were still large and serviceable,‡ but such degeneration of the dental apparatus with advancing years is surely not to be taken as a character of specific value.

The only important difference between the descriptions of Dr. von Haast and Burmeister is the presence of one pair of ribs less in the New Zealand skeleton; but this is so violent a departure from the number obtaining in a so closely allied, even if not an identical species, and from the number found in all other ziphioids except *Hyperoodon*, that it should, I think, be attributed to individual abnormality or an accident to the preparation.

One important feature in Burmeister's description has not been alluded to by Dr. von Haast, namely, the presence not only of the large terminal mandibular teeth, but also thirty small teeth in the gum of the mandible and twenty-five on each side in the gum of the upper jaw. As the Buenos Ayres specimen was quite young, measuring only 18 feet in length, whereas the Canterbury specimen was adult, and measured 29 feet, the absence of the functionless teeth in the latter was probably due to the difference of age. This is clearly opposed to the generic value attributed to such organs in the case of *Oulodon*.

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* Trans. Roy. Soc. Edin., XXVI., 759.

† Trans. N.Z. Institute, V., 166. ‡ Trans. N.Z. Inst., V., pl. 4 and 5.

III.—BOTANY.

Art. XLVI.—*On Grasses.* By S. M. Curl, M.D.

[*Read before the Wellington Philosophical Society, 1st September,* 1877.]

I had the honour on a former occasion of laying before the Wellington Philosophical Society the results of some of my observations on those grasses and fodder-plants that, from experiment in acclimatization, growth and culture, and after chemical analysis, grazing of cattle and horses, and folding of sheep upon them, had been found to be valuable for the grazier and farmer to introduce into their fields and pastures, with the object of making them far more productive than they are at present with the grasses and clovers usually sown.

It is well known that there is a great scarcity of grass in the pastures during the dryness of summer, and also in a cold or wet winter; my experiments have proved to me there were exotic grasses that would supply this deficiency, and clothe the pastures at all times with abundant and nutritious herbage. In addition to the grasses already mentioned in my former paper, I now desire to give you the results of further experiments upon other new grasses not hitherto cultivated by farmers and pastoralists in New Zealand. It is probable that for a considerable period pastoral pursuits will be more profitable to many of those who come to invest their capital in New Zealand than the growing of cereals.

That the profitable return to individuals and the money introduced into the colony for the wool, tallow and other produce may be the greatest in proportion to the quantity of land occupied by the sheep, cattle, etc., it behoves the pastoralist to make two blades of grass grow where one grew before, and also that these two blades shall be of a more nutritive kind than the one was. Therefore as competition within and without the colony is likely to increase, the pastoralist must make up his mind to grow not only the best and most fattening grasses, but sow such a variety of them that he will be able to keep the largest number of stock upon his land both summer and winter. But as, in addition to the graziers, there will be a large number of colonists who, having labour within their own families, or who for other reasons will be able to carry on the cultivation of cereals conjoined with the production of meat, wool, etc., in a rotation of agricultural operations, it follows that these farmers will find it best to grow the most suitable grasses upon their fields during the time the live-stock

are feeding thereon, so that these cattle may in the shortest time be ready for the market. But the operations of these graziers and farmers will necessitate their growing upon their several lands very different species of grasses. To the grazier permanency will be a great recommendation in the grasses he selects, while to the farmer, although the grasses must be both fattening and nutritious, yet he will only require them to be annuals and biennials, so that they may not occupy his land more than one or two years after sowing.

But these are not all the conditions necessary in the selection and sowing of grasses, it is requisite to choose those that will best suit the kind of soil, its topographical situation, annual state of moisture, chemical constituents, and many other circumstances. A grass may be very valuable when planted on one piece of ground, and nearly worthless when planted upon another. The grazier or farmer is often surprised that a grass or clover he has seen extolled in books, etc., will not grow upon his land, or if it manages to keep itself alive will bear but little herbage, and that little will not fatten his live stock, or cause them to grow wool; or a grass may be very good of itself, but in the struggle for existence some more vigorous grass may overgrow and kill it, as for example, the *Holcus lanatus* will destroy the doob, or any weaker growing grass near it. Therefore it is necessary that before any grass or clover is sown, these various conditions and many others must be taken into account and attended to, that the best results may follow. For there is all the difference between keeping a sheep to the acre, or ten, or even more, or one head of large cattle to every five acres, or one or two bullocks to every acre, and to fatten them by the time they are twenty-four or thirty months old. It is no use purchasing valuable short-horn cattle, or Lincoln or Leicester sheep, if the pastures are not what they ought to be by the grass growing vigorously and with its chemical constituents properly combined, thus producing the largest amount of nutritious food, for, as Mr. Bakewell said, "It is the feeding more than the breeding that tells."

The pastures may even look green, but the stock may not thrive, and upon the chemist testing the grasses his analysis may show that the minerals and organic elements are not normally proportioned. But, further, while one grass will fail to feed, or will not even grow, another species in the same place will thrive and bear abundant herbage, and both nourish and fatten stock.

We have lately seen wonder expressed at the rye and other grasses affected with the ergot fungus (*Secale cornutum*) and that stock fed thereon suffer. This is apparently a great mystery to some, but none to the

scientist, as he knows that whenever a plant is growing in an unhealthy condition, it is liable to the attacks of disease, and becomes the host and supporter of parasites.

In experimenting with grasses and fodder plants, it is therefore necessary not only to introduce them from distant countries where they are indigenous, and acclimatize them, but, after they are acclimatized, to grow them upon various kinds of soil, and under different conditions; the soil of the experimental beds must represent these soils and conditions, or the experiments are worthless. The soils must vary between a light sandy mould, sandy loam, stiff loam, friable clay, stiff clay, calcareous sands and marl, and must be drained and undrained. The experiments must be carried on during summer and winter, and the resulting herbage must be weighed, measured, and chemically analyzed during the first three years of the experiments, and then fed off by live stock pastured thereon for definite periods, according to the results desired to be tested, and this for not less than three years, as the first year's feeding power is often different from the subsequent second, and third years. The grasses have after this to be allowed to seed, and this seed then to be sown with twelve or more vigorous grasses and clovers, and if these do not smother them they are able to take their places *among grasses for permanent pastures.* If they do not stand this test their merits are known, and they can be placed in the position they ought to hold as fodder or temporary grasses.

For these and many other reasons I find it very difficult to predict what any grass will really be until actual experiment in growth and testing has revealed its qualities. Amongst the hundreds of grasses I have grown from many parts of the world, I am never able to say with certainty, until after years of continued experiment, what a grass will be worth in permanent or temporary pasture; some that are very poor for the first few years improve with each year after they have been planted out permanently among the mixed grasses and grazed over, whilst others cannot stand against more vigorous grasses, or the grazing and trampling of stock, or they are not able to send their roots far enough for them to obtain a fresh supply of elements, after they have been located some time in the pastures.

Thus the so-called perennial rye will bear feeding down for two, three, or four years, according to the seed or choice of soil and amount of stocking, and then will lose its normal chemical elements and get weaker and diseased until it will die out, and be replaced after a few years—more or less—according to circumstances, by *Holcus lanatus*, or by weeds, or if the ground is undrained when it dies out, rushes will take its place, or as it requires for its healthy growth lime and potash salts, sheep feeding it off constantly will gradually remove in their wool and bones these elements;

it gets diseased and attacked with ergot (*Puccinia uredo*), etc., and will be replaced by other plants in its struggle for existence.

One other condition that must be noticed, and a very important one, is the period of rest during which the plant ceases to grow *above ground*, and either remains with only small growth in any part, or nearly quiescent, or in other species commences vigorous root action and extends under ground, this being regulated by the decreasing or increasing temperature, height of ground water, by which we understand the mean summer and winter water, level or height of moisture in the soil. The above and below soil changes of growth taking place in different grasses depending upon their species, original habitat, etc., at various seasons of the year in this island, either in the spring, summer, autumn, or winter, and all other things being equal, this growth above ground will determine at which season a grass is most to be depended upon by the graziers and farmers in this colony.

The *Panicum spectabile*, which will be growing vigorously from October to April, will die down in the winter and only maintain a weak root-action until spring, while the *Bromus unioloides* will grow as fast above ground in the winter as in spring, and not so rapidly during the summer and autumn. The *Anthoxanthum odoratum* grows all the winter, spring, and autumn, and is a good feeding grass during those seasons.

The *Elymus condensatus* grows fastest during the spring and autumn, continuing to grow, though less vigorously, in winter and summer.

The *Stenotaphrum glabrum*, so-called buffalo grass, and *Cynodon dactylon* or doob grass, grow best during the hottest and driest weather here, and whilst the Californian alfalfa with irrigation will make enormous growth during the summer; the Chilian alfalfa grows on also in the autumn and winter.

The *Trifolium repens* makes its principal growth in the spring; the *Lolium perenne* gets weaker after the first three or four years; while the *Alopecurus pratensis* becomes a much better grass in permanent pastures after this period; and although here on swamps and peat bogs many of the English pasture grasses will not thrive, the *Agrostis stolonifera* there grows well and is very fattening to cattle. The *Poa aquatica* and *Festuca aquatica* will thrive best by the sides of rivers, streams, and damp places, making there the best feeding grass; while the *Elymus arenarius*, and *Paspalum littorale*, and *Achillea millefolium*, and some others will grow on nearly pure sand and be then relished by stock, so much that some of my sheep selected the *Elymus arenarius* from many other grasses in preference to anything else.

The *Dactylis cæspitosa* is said by some authorities (but of this I cannot speak from personal experience at present) to grow best in swamps by the

sea; and I know the *Holcus lanatus* will grow on most soils, however stiff or wet they may be, as well as the *Plantago lanceolata.*

The *Cynosurus cristatus* will make a permanent pasture for sheep on the driest and poorest gravelly downs, and be greatly assisted by the *Pentzia virgata,* or Cape-sheep bush; whilst the *Onobrychis sativa* will only grow profitably for feeding on soils containing a considerable proportion of lime; while upon lands shaded by wood or overgrown by trees several *Poas* will grow well, as will also the *Panicum decompositum, Arundinella nepalensis,* and other kinds. The white clover will grow and ripen its seed where bees and other insects can be found. In this colony, the red or *Trifolium pratense* finds very few insects capable of carrying pollen grain to fertilize it, as the humble bee that fertilizes it in England we have not here; yet sometimes I have had a patch of this clover with perfectly fertile seeds, and though I am not yet able to say positively what insects are the fertilizing agents, I am inclined at present to think it is the ant that does it—but I hope soon to learn more of this from test experiments now going on. And again, while many of the grasses and clovers will cease to fatten sheep and produce disease in them if they eat them when their young growth is first commencing in spring, *Phleum pretense* will stop the diarrhœa produced, and will continue to nourish and fatten them at a time when other grasses will not do as well; and this being a good autumnal grass, and very nourishing at other seasons, it should be more sown than it is at present. So well do the Canadian and North American farmers and graziers know its worth, that they sow it very largely, and often to the exclusion of the *Loliums,* for sheep and cattle pasture.

Another genus of grasses very valuable for permanent pasture are the fescues—*Festuca gigantea, F. elatior, F. pratensis, F. rubra, F. duriuscula*—and many others of these valuable grasses are in this climate growing vigorously, and yielding herbage in the winter when the so-called perennial rye is nearly dormant. These fescues, sending their roots deeply down, find elements to assist their healthy growth when other grasses are attacked by fungus and other diseases; and the instincts of sheep and cattle will cause them to crop these grasses in certain seasons instead of any others.

Among the red clovers for permanent pastures in this colony, none are better than the *Trifolium pratense perenne,* or cow-grass, as it not only continues to grow year after year when it has been sown, and produces a large amount of herbage, but it very frequently has its seeds fertile, and sows itself down if not too closely cropped in the autumn. In a small paddock in which I had it sown some years since with many other kinds of grasses, plants of it are to be found far distant from the place in which it was originally sown, and each year I observe an increasing quantity of plants.

The Californian variety of lucerne or Californian alfalfa, which has during the past two years been much written upon in the various agricultural journals, is a very useful plant, as it will grow a very large and abundant crop of herbage either for fodder or making into hay, or for grazing upon with periods of rest between the grazings. It forms much larger roots than the other lucernes, and is in several other respects different; it is well worthy of culture by the graziers and farmers. The plan that I have pursued with it is to allow my cows or bullocks to feed upon it for two weeks, then take them out and place sheep on it for two weeks to eat it close to the ground; then remove them, and leave the alfalfa to grow for a month, and then follow this course again; and for the two weeks I allow five large cattle or twenty sheep to the acre. It requires to be grown in different enclosures to pursue this system, so that while the stock are feeding in one enclosure the other is at rest and able to grow again.

Another plant, called the prickly comfrey, has recently been recommended as a fodder or soiling plant. It was introduced into notice in 1811, and at that time recommended for fattening stock, but passed out of notice, and has since been revived. Of the several comfreys, *Symphytum asperrimum* is the one now most in favour. As soon as I noticed the renewal of interest in it, I ordered plants from France and elsewhere, and, having obtained them, have now placed them under test culture; but the time is too short to be able to give any details as to their worth or capabilities in this colony.

Agrostis argentea.—A perennial grass of great merit, grows vigorously through the spring, summer, and autumn, and part of the winter, yielding a fair proportion of nutritive herbage, seeding freely if allowed to do so. It is readily eaten by stock, holds its own amongst other grasses, and is a valuable grass with mixed permanent grasses on runs or pastures.

Anthistiria australis.—The seed of this widely-spread Australian grass I obtained from Tasmania, the seed came up late in the spring; it sent up seed-heads which were three-and-a-half feet in height. It was cut for seed about the latter end of December; it continued to grow during the summer and autumn, until the frosts of winter became severe, when it remained with only small growth during the remaining months, till spring weather started it into fresh growth, when it grew well, yielding much herbage to the stock grazing upon it. It possesses elements well fitted for the growth and development of sheep and cattle, and is a good grass for permanent pasture, but is better for not being too heavily stocked.

Avena argentea.—A permanent pasture grass growing an abundance of foliage during the autumn, winter, and spring, but somewhat less during the dry summer weather; it contains a large amount of nutritive and

fattening material. It does not readily ripen fertile seeds but forms plenty of empty glumes. It is a good grass for permanent pasture.

Arundinella nepalensis.—This excellent summer grass commences its growth in the first warm spring weather, and continues to increase during the whole summer, forming in this climate a dense mat of foliage, which grows as fast as it is cut or eaten down, continuing its growth until the coldness of winter stops it. It is especially in this latitude a summer grass, but valuable for its rapid growth at that season, and thrives on high dry land.

Alkali grass of British Columbia.—A most valuable perennial hardy grass, grows well during the winter, spring, and autumn in this island, and is a very useful grass, well worth introduction into the permanent pastures here.

Agrostis rubra.—Procured from the United States, an excellent permanent grass, grows from early spring to a late period of the winter, sending up delicate, short, thick herbage, filling up spaces amongst other mixed grasses; spreads more by seeding than by its creeping stolons; in this differing from many others of its genus.

Andropogon annulatus.—This is here both a summer and autumn grass; it does not grow fast here during the winter, but at the period of its greatest growth sends up an abundance of herbage; it is an excellent pasture grass.

Chloris truncata.—A perennial grass of good quality for summer pasture, growing freely during the spring, summer, and autumn months; it does little during the winter here, so must be relied upon for its herbage during the hot, dry summer season, when the stock like it much. It fattens them, and if not too closely cropped down, it seeds and spreads freely.

Chloris divaricata.—This is here principally a summer grass, but grows very late into the autumn; it is useful at all seasons of the year, ripens its seed well and sows itself down, thus spreading and filling up vacant places.

Chloris ventricosa.—This like the preceding grass grows in the dry and hot weather, producing a fair quantity of feed which the stock are fond of, as they leave many others for them.

Dactylis glaucescens.—In appearance this grass much resembles the common cocksfoot or orchard grass except in its bluer colour. It also grows much later into the winter than the cocksfoot, and is a better grass for supplying winter feed; it also contains more starch and sugar elements in its foliage than the other species of that genus. It is a very useful grass for permanent pasture.

Eragrostis elegans.—Although an annual, is a useful grass for those who only want a grass of this character, as it sends up an abundant nutritious herbage through the spring, summer, and autumn.

Helopus annulatus.—This is a very excellent and fattening grass; grows

all summer during the driest weather, much relished by the stock, and a very desirable grass for permanent pasture, bears a great quantity of seed, and as it lays many of its stems along the ground that escape the grazing of the stock, it thus increases and spreads. It is very nutritious and fattening, and well worthy of a place in pastures.

Panicum decompositum.—A fast-growing abundant grass, grows well under trees, forms a thick sole, and during summer is a rapidly increasing plant, able to ripen seed in large quantities through all the autumn: grows from spring to late autumn.

Panicum orizynum.—A quick-growing grass, much to be recommended if quite closely kept fed down, but it must not be allowed to form seed-heads, as the long awns upon its seed might injure the cattle; if closely cropped would be very useful, as its abundant leaves contain a large amount of nutritive elements.

Pennisetum italicum.—This, although an annual, will be found very useful by the farmer for one of the grasses for a rotation crop; it bears an abundance of very fattening foliage, which is three feet high; it forms large bunches of leaves and tall seed-stems, and is greedily eaten by cattle and other stock, quickly making them fat.

Pennisetum glaucum.—Is also an annual, and distinguished from the preceding by its glaucous colour, taller herbage, and later growth; in the season of its greatest vigour it is a very fattening grass, and should be sown by farmers and others who only require an annual grass; it may be fed down very closely, quickly growing up again.

Paspalum distichum.—A useful grass to sow in damp places or along the banks of water-courses. It yields an abundance of nutritious herbage during the warm weather that stock much approve of. It is a very superior grass, and should be widely sown in permanent pasture, more especially on damp lands or swampy meadows.

Paspalum littorale.—A very good grass for sandy lands along the sea coast, and is there one of the best feeding grasses.

Paspalum dilatatum.—A valuable perennial pasture grass, as it yields an abundance of herbage, it fattens stock quickly as they are fond of it; it holds its place so well amongst mixed grasses that it ought to be generally sown in permanent pasture.

The preceding are a few grasses and fodder plants selected from my notes upon many hundreds of such plants as I have introduced, acclimatized, and experimented with during the past eighteen years, and although there is a great temptation to add largely to the number above described, yet a fear of wearying the members of the Philosophical Society, by adding many others to the list upon this occasion, causes me to limit the number to those above

mentioned, for although I feel the greatest interest in procuring, acclimatizing, cultivating, experimenting with, and testing all obtainable grasses, fodder plants, all kinds of edible plants, fruits of every kind, timber and other trees, in fact, every kind of economic and useful plant, yet to others who are not so enthusiastic, a very long list and description of grasses and fodder plants at one sitting would only be tiresome. Yet to the farmers and graziers the subject of adding more to the present grasses and plants those that will increase the feeding and fattening powers of their lands, must be one of importance, and it would be almost impossible for many of them to obtain from various parts of the world the many hundreds of grasses and test them for themselves.

As the Government of this colony have not thought it desirable to have an acclimatization ground or botanic garden, in which a proper set of experiments could be carried out upon the grasses and other economic plants, it has been left to private persons to introduce and experiment upon these plants. We have to procure them at considerable risk and cost from the various nursery and seedsmen in Europe, America, and elsewhere, or obtain them from friends engaged in similar pursuits, and had it not been for the kindness of Baron von Mueller, Dr. Schomburgh, Mr. Bacchus, Mr. Way, Mr. Phillips, and other botanists and experimentalists, it would have been almost impossible to have obtained many of the very valuable Australian grass seeds and test them here. The same remark applies to European and Asiatic plants and seeds, as the nursery and seedsmen cannot or will not execute the orders sent, the seeds often not being in their stock for sale.

The time of the Society will not be therefore, I trust, altogether wasted in listening to a description of some of the grasses which have proved themselves to be very useful for what they are recommended, as adding to the number of feeding plants for the live stock of this colony will not only be of advantage to the farmers and graziers, but to the general prosperity of colonists, and all connected with this country who may be concerned in the growth and development of the trade in wool, meat, and other produce of the sheep and cattle here pastured.

ART. XLVII.—*Notes on the Fertilization of* Glossostigma.

By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 28th May, 1877.*]

THE remarkable sensitiveness of the upper part of the style of *Glossostigma elatinoides* does not appear to have been previously noticed. As the facts of the case, though simple enough, are yet peculiar, and may perhaps possess

some little interest for those naturalists engaged in the study of the varied modes of fertilization in use among plants, I have drawn up the following notes on the subject.

Glossostigma elatinoides is a small, creeping, intricately branched moss-like plant, generally found in wet swamps, or by the margins of lakes and ponds, often growing entirely submerged. The flowers, which are axillary on short peduncles, are very minute, hardly exceeding $\frac{1}{8}$ inch in diameter. The corolla has a short tube and five nearly equal spreading lobes; the two upper, however, are rather smaller and more closely united than the lower. The margins of all the lobes are fringed with numerous minute ciliæ, and the cellular tissue throughout is unusually lax. The stamens are four in number, two long and two short, the anthers being approximated in pairs, one above the other, as in so many of the *Scrophularineæ*. The style is about the same length as the corolla. At the base it is nearly cylindrical, and very slender, but above the middle it expands into a broad and thin spoon-shaped lamina, the anterior surface of which is quite smooth and plane, but the back covered with delicate clavate papillæ pointing upwards towards the summit of the style.

On examining a recently expanded flower, it will be observed that the broad end of the style is abruptly doubled over towards the front of the flower, thus covering the stamens and entirely concealing them from view. If the point of a needle, or stiff bristle, be inserted into the corolla, and the front of the stigma lightly touched, it at once springs up and uncovers the stamens, moving back to the upper lip of the flower, to which it becomes so closely applied that it is difficult to distinguish it from the corolla without the use of a lens. After a short time the style gradually moves inwards, and ultimately bends over the stamens as at first. With the view of ascertaining the time which elapses before the stigma resumes its normal position, I made the following experiment. At 9 a.m. I touched the stigmas of seven flowers, causing them to uncover the stamens and occupy their position at the back of the flower. At 9·12 one of the styles had commenced to move inwards; at 9·15 all had advanced a considerable distance; at 9·20 five out of the seven covered the anthers as closely as at first; at 9·25 the whole of the seven had resumed their original position. Further experiment also showed that the stigmas may be repeatedly touched, but always retain their sensitiveness until the flower commences to wither.

It cannot be doubted that this irritability of the style is connected with the fertilization of the plant—in fact, that it is solely a contrivance to secure cross-fertilization possibly so arranged that if the flower is not visited by insects self-fertilization is not prevented. Let an insect crawl into the flower, or let a larger one insert its proboscis; it would be difficult for either

to avoid touching the upper part of the style, which would then move back and expose the anthers. On retiring, the insect would in all probability dust itself over with pollen, but it would not by this effect the fertilization of the flower, as the stigma would then be closely applied to the upper lip of the corolla,—entirely out of its path. But let the same insect visit a second flower, and it is then every way likely that some of the pollen would be rubbed off by the stigma, which as we have seen, would be naturally touched on the first entrance of an insect. I have not been able to systematically watch the flowers so as to ascertain what species are instrumental in transferring the pollen, but I have twice observed small Diptera engaged in sucking the flowers. Several of these I caught, and found grains of pollen on the foreheads of some of them. The common red ant is often found crawling over the plant, and I have seen one emerge from a flower with the front of its head thickly covered with yellow pollen, thus proving that this species may play no unimportant part in the fertilization of the plant. Their visits would not, however, be so beneficial as those of winged insects, which would be more likely to bring pollen from distinct plants, and thus effect a more advantageous cross.

Late in autumn the plants are usually covered with capsules, so that, if fertilization is chiefly performed by insects, they certainly fulfil their duties in an effectual manner. In old flowers that have been seldom visited it often happens that pollen drops from the anther-cells on to the face of the style bent down just below; and I perhaps too hastily concluded that self-fertilization would thus inevitably take place if from any reason the flowers were not visited by insects. I did not, until almost too late in the season, pay sufficient attention to the difference existing between the two surfaces of the expanded portion of the style; and I am now inclined to believe that only one is stigmatiferous—the posterior one, or that turned to the back of the flower when the style is erect, and to the front when it is curved over the stamens. Certainly this surface alone possesses well-developed stigmatic papillæ, and on it alone have I been able to observe the development and intrusion of the pollen-tubes. If this view is correct, self-fertilization would be almost, if not altogether, impossible.

The movements of the style in *Glossostigma* form the most curious example of irritability in the female reproductive organs of plants that I am acquainted with, excepting that produced by a slight touch on the gynostemium of *Stylidium*. The closing together of the two arms of the style in *Mimulus* and allied genera is analogous; but in the case of these plants the movement is rarely through a greater angle than 60° or 70°, and is usually much less; while in *Glossostigma* the point of the style moves through an arc of at least 180°. On referring to the description given by

Mr. Bentham in his "Flora Australiensis" of *Peplidium* and *Microcarpæa*, two genera closely allied to *Glossostigma*, I find that the style is described as "short, dilated into a broad spathulate lamina curved over the stamens," being almost the same language made use of in describing the pistil of *Glossostigma*. It would be interesting to know whether these two genera possess the singular irritability now noticed.

Art. XLVIII.—*Description of a new Species of* Polypodium.

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 19th November*, 1877.]

During an excursion made in January last for the purpose of examining the vegetation of the district between the Waipa River and Raglan, I was greatly interested by collecting an evidently undescribed species of *Polypodium* at an altitude of about 2,000 feet on the Pirongia Mountain. A few days later, the same plant was gathered on the summit of the isolated mountain Karioi, between Raglan and Aotea. As in all probability it will be found that the species extends from these two localities southwards through the little known Upper Waipa and Mokau districts, and perhaps even still further south, I have thought it advisable to draw up a brief account of its distinguishing characters in order that the attention of collectors in other parts of the colony may be directed to it. I will not, however, confer a name upon the species, as this may have been already done in England, specimens having been forwarded to Kew immediately after its discovery.

Polypodium (Phymatodes), sp. nov.

Rhizome stout, woody, as thick as the fore-finger, densely clothed with large tawny ovate-lanceolate spreading scales. Stipes 6–12 inches long, quite glabrous, erect, smooth, and glossy. Frond dark green, 1–2 feet in length, 8–12 inches broad, in the upper part cut, down to within a short distance of the rachis, into numerous linear acuminate entire lobes; sub-pinnate below. Lobes varying in number from 5–14 on a side, 4–8 inches long, usually about ½ inch wide, lower ones often narrowed towards their bases. In large specimens it often happens that the lower lobes are free to the main rachis, so that the frond might be described as pinnate in the lower half. Texture sub-coriaceous, or sometimes almost papyraceous; both sides quite glabrous; main veins indistinct, areolæ rather large, with included free veinlets. Sori rather small, in a single row, nearer the margin than the midrib, slightly immersed.

Hab. Pirongia Mountain, not uncommon above 2,200 feet alt.; Karioi Mountain, near the summit of the highest peaks, alt. 2,300 feet.

From the above description it will be seen that the species is closely allied to the variable and widely distributed *P. billardieri*, but from all the forms of this plant it can readily be distinguished by the rhizome being densely clothed with shaggy spreading scales entirely different in appearance from the closely appressed squamæ with which the rhizome of *P. billardieri* is furnished. It is also a larger plant, the fronds being often over 2 feet in height; the lobes are far more numerous and much narrower; the venation is more indistinct, the texture thinner, and the sori smaller. In addition, I failed to observe any tendency to the polymorphism of the fronds so well marked in both *P. billardieri* and its near ally *P. pustulatum*. All the plants seen had their fronds uniformly lobed in a pinnate manner as described above, and simple-fronded specimens could not be found. I should perhaps mention that the ordinary forms of *P. billardieri* and *P. pustulatum* were abundant in the same locality; indeed, the three plants could be seen growing side by side.

NOTE.—22nd December, 1877. Since writing the above I have been informed that a new *Polypodium* has been recently discovered by Mr. H. C. Field in the forest country to the west of Ruapehu. Not having seen specimens I am unable to state positively that Mr. Field's plant is the same as mine, but from the description given to me I have but little doubt that the two are identical.

ART. XLIX.—*Note on a branched Nikau Tree.* By S. PERCY SMITH.
Plate XV.

[*Read before the Auckland Institute, 22nd October,* 1877.]

THE following short note has reference to a nikau palm, which in its manner of growth presents some features of an abnormal character. It was discovered by one of the survey parties growing in the forests at the base of the Tangihua Mountains, Whangarei, and it was on a late visit to that district that I had an opportunity of seeing this vegetable curiosity.

Most people are acquainted with the ordinary nikau palm (*Areca sapida*) of New Zealand, with its smooth cylindrical stem encircled with equal rings of annual growth, and surmounted with a luxuriant crown of wide-spreading leaves. The stem is nearly always quite straight without branch or knot or bend in it to spoil its symmetry. The subject of this note, however, has eleven separate and distinct branches growing from one parent stem, most

of which separate from the main trunk at about five feet from the ground and after rising some ten feet higher some of them divide again into other branches.

The tree itself is about nine inches in diameter at the ground, and about six inches just before it divides, the branches being from three to four inches each in diameter. The total height of the tree is about thirty feet, and each branch is crowned with a fine head of luxuriant leaves, forming altogether a most beautiful object. The forest around contains hundreds of ordinary nikaus with single stems, but none with any sign of branches. There was no fruit on the tree, though others in the vicinity were in bearing; this may not, however, be owing to any barrenness in it, for it is stated that the palms do not bear seed every year. It would be rather interesting to ascertain whether the seeds of this particular tree would produce branched offspring like itself.

Since seeing this tree I have made inquiries of several old bushmen and others with a view of eliciting whether they had ever seen or heard of the like before, and with one exception have been answered in the negative. In this case my informant stated that he had seen a deformed specimen which had divided into two branches—the cause of which he attributed to accident—such as the falling of a tree into its head, by which it would become divided but still have sufficient vitality to recover the blow. I do not attempt to assign any cause why this tree differs from its fellows, but simply bring the matter before the Society as an example of a marked deviation from a general form of vegetable life. The accompanying sketch (pl. XV.), copied from a rough one taken on the ground, will give a much better idea of the tree than any description I can give.

Art. L.—*Notes on Ferns.* By T. H. Potts.

[Read before the Philosophical Institute of Canterbury, 6th December, 1877.]

The writer offers a few notes on the habits and localities of some of our ferns, trusting they may be of some interest, as habitats are given not mentioned in "Hooker's Handbook." One cannot fail to notice the great changes that are daily taking place in the natural aspect of the country. More especially is this the case in forest lands, where a vast amount of timber has been used up or destroyed within the past ten years. Ten years ago is about the date of Dr. Hooker's most valuable Handbook of the New Zealand Flora. In that work of reference, "abundant throughout the islands" is a constantly-recurring phrase as applied to ferns. This

S.P. Smith, del.

BRANCHED NIKAU PALM.

expression would be found no longer applicable in many parts of the country.

Alsophila colensoi, Hook.

Perhaps the hardiest of our tree-fern group, it may be found in mountainous districts, sometimes in very exposed places on the outskirts of bush, at an altitude of from 2,000 feet to 3,000 feet. Trunk often absent or prostrate, exposed or covered with soil, from two to four feet long. Where fronds have been exposed to the rigour of severe winters, they assume a rich cinnamon hue. Malvern Hills; near mountain tops on Banks Peninsula.

Hymenophyllum bivalve, Swartz.

On rocks or trees, in thick masses in bushy gullies, west of Mount Somers; also plentiful on Banks Peninsula.

Hymenophyllum javanicum, Spreng.

This filmy fern flourishes near waterfalls, often in a bed of moss together with *Polypodium grammitidis*. Its habit is tufted, more so than is usually the case with *Hymenophyllaceæ*. In rocky gullies near the Rakaia Gorge; also westerly as far as the Havelock River, at about 2,200 feet above the sea.

Hymenophyllum malingii, Mett.

One of the nearest habitats of this very peculiar fern is amongst the ranges of Banks Peninsula. As, under our present system of the administration of lands, the peninsula forests will probably be exterminated at no distant date, perhaps the following notes may be worth recording.

This fern usually occupies a dry place on a decaying limb or trunk of a tree, at a distance of several feet from the ground. We have found it on *Podocarpus totara*, *Libocedrus doniana*, etc., etc. From the similarity of its varying tints and shades of greens, greys, and browns, it may be easily mistaken for a patch of lichens. We have not met with it carrying its fronds erect, as described in Hooker's "Handbook." Its pendent fronds form thick imbricated masses; its thick woolly tomentum enables it to catch and retain moisture gathered from mountain fogs and mists; its rough rhizome creeps amongst and through the ragged strips of soft bark, and even penetrates the bark itself. The young frond, where it shoots from the rhizome, has at the swollen base of the stipe a dense patch of hair or scales; the stipe itself is sparsely sprinkled with pale brown hairs. Just below the rachis the tomentum is dense, as it is indeed over every part of the frond. The growing frond soon loses its crozier state, uncurling into a lunate form; colour buffish, changing to greyish-green with a silvery glint; the terminal divisions with the sori orange-brown. Some of the lower pinnæ are darkish-green above, reddish-brown beneath. With the

aid of a good glass, the stellate tomentum that so closely envelopes this singular plant presents a most curious and interesting appearance. We have collected this *Hymenophyllum* in the bush above Port Levy and Pigeon Bay, sometimes growing in company with a small form of *H. bivalve.*

Rhizome slender, creeping, rough, fulvous, with a few scattered tawny scales, or hairy. Stipe, base gibbous, tomentose, long, slender, 2–3 inches long; upper portion immediately below the rachis densely tomentose. Fronds pendent, narrow-oblong, 2–6 inches long, 1–1½ inches broad, bi- tri- or quadripinnatifid; covered above and beneath with a close tomentum; upper surface greyish-green to buff, dull reddish-brown beneath. Divisions long, narrow, almost terete; sori terminal on the segments, clothed with shaggy hairs, rather dark buffish-brown; the whole frond coriaceous, stiff, rather harsh to the touch.

In the "Synopsis Filicum" it is placed next to a South American fern, *H. sericum*, with which it is said to be closely connected. In Hooker's "Handbook of the New Zealand Flora" it was grouped with *Trichomanes.*

Trichomanes venosum, Br.

On the rhizome of *Todea hymenophylloides;* on the stems of tree-ferns, such as *Hemitelia smithii, Dicksonia squarrosa;* in the bushes of Banks Peninsula, including the Port Hills.

Cystopteris fragilis, Bern.

On grassy terraces near the gorge of the Rakaia river; in Mount Guy valley in the Upper Ashburton district; River Havelock, Upper Rangitata; on the lower spurs of Mount Herbert, Banks Peninsula. Altitude of habitat varying from 500 feet to about 2,500 feet.

Adiantum diaphanum, Blume (?).

In the gorge of the Rakaia river the writer collected an *Adiantum* which is probably *A. diaphanum.* It differs somewhat from the diagnosis given in Hooker's and Baker's "Synopsis Filicum." Should it prove to be *A. diaphanum*, this subalpine habitat is worth recording. The rock from whence it was taken is about 900 feet above sea-level. Stipe slender, polished, blackish, 3–4 inches long. Frond—4–6 inches long, 1–1½ inches broad; simply pinnate, rarely with one feeble branch at the base; pinnules ½–1 inch broad, ¼–¾ inch deep; lower margin decurved; upper and outer line cuneate, texture thin, surface on both sides naked. Sori few, not contiguous.

Pellæa falcata, Br.

Amongst dry rocks, in bushy ravines, on slopes of Dun Mountain, Nelson.

Lomaria duplicata, Potts.

On referring specimens of this fern to the authorities at Kew, it was

judged to be a variety of *L. procera.* A plant the writer has under cultivation has nine fronds (barren and fertile) exhibiting the peculiar habit from which it was named.

L. patersoni, Spreng.

Near springs or rills in gullies and outskirts of bush on Banks Peninsula; in similar positions in the Malvern Hills it may be found growing in the greatest luxuriance, fronds giving a measurement of above 3 feet in length.

Asplenium trichomanes, Linn.

In crevices of rocks in the gorge of the Ashburton river, on the lower spurs of Mount Herbert.

A. flabellifolium, Cavan.

The finest form of this elegant fern that has fallen under the writer's notice was obtained amongst sheltering rocks in the dry bays of Lake Ellesmere.

A. falcatum, Lam.

Fine specimens on *Podocarpus spicata*, near Akaroa.

Aspidium aculeatum, Swartz.

Often found growing as a parasite, most frequently on aged specimens of *Griselinia littoralis* (broadleaf) in the bush, lying high on Banks Peninsula.

Gymnogramma leptophylla, Desv.

Abundant about the rocks in Port Cooper up to the head of the harbour. This delicate fern can be cultivated with little trouble; it is produced freely wherever the seed has been permitted to ripen; in crevices amongst moist rocks or stones it soon becomes established.

Gymnogramme alpina, sp. nov.

Rhizome dark brown, stout, ascending, clothed with brown scales. Fronds silvery-green above, oblong, narrow, 1–3 inches long, half inch broad; pinnate, densely villous, soft, thick in substance. Stipe silvery-green or brownish, tufted, stout or slender, densely villous. Pinnæ petioled, except the last three, in pairs or alternate, delfoid or cuneate, with two or three blunt irregular-shaped lobes, both sides densely villous, veins flabellate; sori ovate, numerous, covering a large portion of the under-surface of pinnæ.

A hardy perennial, growing in crevices of rocks on steep facings of the Southern Alps at an elevation of some 3,000 feet. In this habitat it withstands the rigours of winter, the severity of which is quite unknown to the dwellers near the coast. It is probably the most densely villous of all the New Zealand Filices; in its soft woolly texture and silvery-grey colours it bears close resemblance to several plants of our alpine flora. Compared with *G.*

pozoi, it lacks the membranous texture of that rare fern, the fronds are crowded, the pinnæ far less distant; the writer names it provisionally *G. alpina*, as appropriate from its habitat.

It was collected by Mr. Gray in the Upper Ashburton district.

Nothochlæna distans, Br.

In the Handbook the habitat of this deciduous fern is not particularized further than North Island, on basaltic rocks, on the authority of Colenso. The writer has obtained it in abundance on the cliffs and rocks about Port Cooper; on the rocks that wall in the creek in Church Bay it is plentiful, growing in close proximity to the much admired *Cheilanthes*.

Art. LI.—*On the Naturalized Plants of Port Nicholson and the adjacent District.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

One of the most interesting branches of scientific investigation is the displacement or replacement of plants and animals which we know is now in progress over nearly all parts of the earth's surface. In islands and continents where man has not taken up his permanent abode, the process is slow but none the less certain; seeds of plants from other latitudes, wafted by the waves, germinate on the shore, and finding a suitable habitat, are gradually diffused through the interior; other seeds, or possibly fragments of plants themselves, are borne by birds, even by insects, or in some rare cases carried by winds; seeds of plants from more distant regions may be accidentally thrown overboard from passing ships, or the sailor landing to inter his dead shipmate, leaves behind him the northern chickweed, or the broad-leaved plantain, which so habitually follows the track of the pioneers of civilization that the North American Indians have poetically termed it the "footstep of the whites." It is easy to realize how by these and similar noiseless agencies, material changes may be produced in the aspect of the flora of an uninhabited country in the course of centuries. But with the advent of man other forces acting in the same direction are brought into operation partly by design and partly by accident, so that for a time these changes are accelerated in a constantly increasing ratio, and the work of centuries is compressed into a decade. The forest is destroyed, the vegetation of the plain is changed, or at least so intermixed with exotic plants that its aspect is entirely new. Foreign weedy plants spread through the land, destroying by their superior vigour much of the original vegetation. In more distant situations sheep and cattle feeding closely upon the herbs, or on the tender shoots of shrubs,

speedily destroy the undergrowth, admitting the light and air. These in their turn act unfavourably on the larger vegetation which has attained its growth in a dark damp atmosphere, and the injurious agency gradually extends over a constantly widening area. But in this colony it rarely happens that the process of displacement passes into complete replacement; it rarely or never results in the extirpation of indigenous species, although it greatly reduces the number of individuals. The admission of air and light, while unfavourable to certain plants, tends to increase the vigour of others, which exhibit a luxuriant growth they had never before displayed, and at length a turning-point is reached, the invaders lose a portion of their vigour and become less encroaching, while the indigenous plants find the struggle less severe and gradually recover a portion of their lost ground, the result being the gradual amalgamation of those kinds best adapted to hold their own in the struggle for existence with the introduced forms, and the restriction of those less favourably adapted to habitats which afford them special advantages. This, in brief, is a statement of the phenomena now in progress throughout the colony; but at present we are not in a position fully to appreciate several of its bearings.

It can scarcely be expected that those who were familiar with the general features of the vegetation of New Zealand before they were modified or changed by the progress of settlement will at once accept the statement I have given as correct. They have witnessed the steady onset of axe and fire, the unceasing advance of cattle and sheep, and they have been so impressed with the almost total extinction of many striking plants over areas where they were formerly abundant, as to have lost sight of the tenacity with which plants in general maintain their existence even under unfavourable conditions, of the surprising power of adaptation which they often exhibit under changed circumstances, and are led to the conclusion that sooner or later the majority of our native plants must inevitably become extinct. I can only share in this fear to a limited extent, and could almost count upon my fingers the particular plants for which such a danger is most to be feared. In no part of the world has agriculture been carried to a higher pitch of perfection than in the British Islands; in no part have the open lands been more completely brought under cultivation; yet we know that under these adverse circumstances not more than two or three species, at most, have become extinct, although many have become extremely rare, and only maintain themselves in situations offering peculiar advantages. The Killarney fern, *Trichomanes radicans*, Sw., has often been reported as extinct, yet scarcely a year passes without some new station being discovered, or some of the old stations proving reproductive. *Asplenium*

germanicum, Weiss, affords another instance of the tenacity with which plants maintain their existence under the most unfavourable conditions. *Adiantum capillus-veneris*, L., *Woodsia ilvensis*, Br., *W. hyperborea*, Br., *Nephrodium cristatum*, Rich., are similar examples. Not only have the plants here named to endure the changed conditions brought about by agricultural and pastoral occupations, but they have suffered largely from the ravages of vulgar curiosity-hunters, who value a thing only for its rarity, and sometimes strive to render the habitat of a rare plant unproductive, in order to enhance the value of the specimens in their possession; and from the mania for fern-collecting, which for years past has been a fashionable pursuit in Britain, as well as from the more legitimate but far less destructive indents of botanists, they may therefore be taken as extreme cases.

Numerous flowering plants exemplifying the same tenacity of existence under unfavourable conditions, and the power of adapting themselves to changed circumstances, might be named, but I will only state that during a detailed examination of the flora of the Auckland Isthmus and North Shore, extending over ten years, I failed to obtain the slightest evidence that a single species had become extinct, yet the district sustains a population of about 25,000 souls, on an area of 43,000 acres, less than half the extent of many sheep runs in the South Island. It is one of the oldest settled districts in the colony, and agriculture is in a more advanced state than in many other places; the only remains of forest are the few small patches of bush at the mouths of gullies between Takapuna and Lucas Creek, all traversed by cattle, while the open lands not actually under cultivation have been subjected to repeated burnings. Yet under these unfavourable conditions this small area, no part of which is above 650 feet in altitude, contains 440 species of phænogamic plants and ferns, representing 78 natural orders out of 91 under which these plants are arranged thoughout the colony, and giving an average of six species to the square mile. Moreover, this area is shared by 300 naturalized species, of which nearly two-thirds are as much at home as the natives of the soil. It is needless to offer further statements in support of my conclusion.

This paper is intended simply as a contribution to our knowledge of the distribution of naturalized plants in the colony and comprises an enumeration of the species observed by the writer in the Wellington district, with a few others for which the authority is stated in each case. It must not, however, be taken as exhaustive, since, without doubt, the list would be considerably increased by a careful examination of the more distant parts of the Wairarapa, the Upper Rangitikei, the country between Marton and Wanganui, and between Wanganui and the southern boundary of Taranaki, with all of which I am personally unacquainted.

In a future paper I purpose discussing in detail the position of naturalized plants with regard to the indigenous flora and their general effect on the progress of the colony, but for the present confine myself to a few remarks on certain species which exhibit features of special interest in this district.

I may, however, point out that the gradual decrease in the number of species as we travel southwards, which to a certain extent characterizes the indigenous flora, is exhibited also by our naturalized flora. Comparing the naturalized plants of this district with those of Auckland, we find the proportion to be less than 1·25 to 2, Auckland having fully 400 naturalized species, Wellington under 250. Making a fair estimate for the number of species yet to be collected in the unvisited portions of this district, it can scarcely be expected that the total will exceed 800; and it may be added that the decrease is more strongly marked as we go further south.

It does not appear that this increasing paucity of species is solely due to a lower temperature. The peach ripens its fruit as thoroughly about Wellington as in any part of Auckland; yet while a constant succession of young trees is produced in the northern district, they are so few about Wellington that, except in peculiarly favourable situations, the plant does not increase when left to itself. The potato exhibits the same difference in a still higher degree: it would stand a much better chance of becoming permanently naturalized in Auckland than in Wellington; while the fig, which never flourishes here except under cultivation, in Auckland, even when utterly neglected, holds its ground and increases by suckers, although rarely by seeds, which in all probability are seldom formed owing to the absence of insects capable of effecting its fertilization. Similar remarks apply to the vine, the Cape gooseberry, and other garden plants, whether producing edible fruits or otherwise; but, on the other hand, the Kentish cherry and garden gooseberry increase with great rapidity when left undisturbed—the cherry both by suckers and seeds, the gooseberry by seeds and the rooting of the lower branches—so that a single wild plant sometimes forms a bush several feet in diameter.

Ranunculus repens, L.

Abundant in wet places, ditches, etc.; more plentiful than in any other part of the colony.

R. parviflorus, L.

This species is becoming injurious in fields and cultivations, from its great abundance and densely tufted habit, which is quite unknown in Europe. It must not be confounded with the var. *australis*, which is indigenous.

Glaucium luteum, L.

Widely diffused on shingly beaches, and from its remarkable habit

producing a singular effect, quite unlike that of any native plants. I am indebted to Dr. Hector for information as to its introduction.

Matthiola sinuata, Br.

A welcome addition to our naturalized plants, but confined to the remarkable locality of Castle Rock, on the steep faces of which it is plentiful enough. Its establishment in this singular habitat can only be accounted for on the supposition of its having been sown.

Lepidium ruderale, L.

This Crucifer appears to be spreading through all temperate regions; sheep and cattle are evidently the chief agents in its diffusion, although its minute seeds are often carried great distances by the wind. It is especially abundant about sheep camps in the Wairarapa and other districts.

Raphanus sativus, L.

Most travellers by the Hutt road must have noticed the profusion of the garden radish on soil disturbed during the construction of the railway. In all probability it will gradually diminish in quantity, although at present it maintains its ground.

Lychnis coronaria, L.

The white leaves and bright red flowers of this plant produce a singular effect in localities where it is abundant, as in Porirua Valley, etc., etc.

Silene noctiflora, L.

This plant appears to be confined to the locality mentioned, where, however, it is tolerably plentiful, and has apparently been established for some years. I am quite at a loss to account for its introduction.

Hypericum androsæmum, L.

Unusually abundant at Ohariu, and flourishing with the greatest luxuriance on the borders of forest to which cattle have access.

Conium maculatum, L.

This deadly plant was more plentiful about Wellington three or four years ago than it is at the present time. Its extension has been greatly restricted by building operations.

Rosa rubiginosa, L.

The sweet-briar spreads with remarkable rapidity, occasionally forming dense thickets and causing much trouble in pastoral lands. Its fruit is eaten by horses and birds, and many of the seeds escape injury during the process of digestion, probably owing to their hairy covering preventing the action of the gastric juice.

Dipsacus sylvestris, L.

In great abundance in the Porirua Valley, where its striking habit affords a marked contrast to surrounding plants. It has not been observed in any other district.

Carduus marianus, Gærtn.

From its great abundance and imposing aspect, the "blessed thistle" is perhaps the most characteristic of the naturalized plants of Wellington. The loose nature of the soil of the hill-sides is highly favourable to the germination of its seeds, so that the plant spreads with great rapidity, forming in the spring large broad masses of bold green foliage with milk-white veins; these are succeeded by its great branched stems three to five feet in height, terminated by the large flower-heads with their recurved involucral spines and purple florets. Its autumn state of ragged decay is less pleasant to contemplate, and the winter winds and rains gradually accumulate fragments of dead stems in large quantities which do not finally disappear for some months.

In Auckland, where a dense sward of grass is soon formed, single specimens of this plant have been known for the past fifteen years; but, although they seeded freely, the seeds had no opportunity of germinating, so that the thistle did not spread. A remarkable exception to this rule occurred during the formation of the Onehunga railway, where a few seeds fell on disturbed soil, grew up and flowered. The railway works being suspended, the plant increased rapidly, and spread wherever it could find disturbed soil. It would be interesting to learn whether it is still able to maintain itself in the locality.

Cryptostemma calendulacea, Br.

The Cape weed, which is plentiful in Auckland, is with us confined to the vicinity of Wanganui, where it is spreading rapidly.

Xanthium spinosum, L.

This (from a wool-grower's point of view) unwelcome intruder is apparently confined to the single locality named in the list, but may be expected to occur not unfrequently in the Wanganui and Patea districts, It is the "Bathurst burr" of the Australian colonists. It is worth while to remark that although this plant has been known in Auckland for the last fourteen or fifteen years, it has done little more than maintain its existence, and can scarcely be said to be injurious. The evils anticipated when it was first observed have not been realized in the slightest degree.

Verbascum thapsus, L.

The "hag taper" is more abundant in this vicinity than elsewhere, doubtless from the same cause that conduces so largely to the spread of the "blessed thistle." Its peculiar habit and woolly leaves afford a marked and not unwelcome contrast to the surrounding vegetation.

Verbena officinalis, L.

This ancient "plant of power" exhibits a luxuriance and profusion altogether unknown in Europe, and, from its usurping the place of nutritious grasses in several localities, is causing direct injury.

Rumex pulcher, L.

The fiddle-dock occurs in great abundance on the formation of new streets, etc., especially in the Te Aro side of the city, but soon becomes comparatively rare. It seems probable that it was one of the earliest plants naturalized here, but that it partially died out, its buried seeds retaining their vitality.

Sisyrinchium chilense, Hook.

A pleasing addition to our naturalized flora, abundant on the hills about Wellington and other places. Apparently restricted to this district.

Iris pseudacorus, L.

The yellow flag or French lily is another welcome addition, probably planted in a tributary of the Waiwetu.

Agrostis alba, L., *β. stolonifera.*

Fiorin grass: a useful addition to our naturalized economic plants, from its affording a supply of herbage early and late in the season on cold clay soils.

Glyceria fluitans, Br.

A valuable grass spreading rapidly in wet places, and affording a large supply of nutritious herbage, especially grateful to horses. The seeds form a large part of the food of the trout in Europe, and in seasons of scarcity have been ground and made into bread.

Briza maxima, L.

An elegant grass abundantly naturalized on the hills about Wellington, but of trivial economic value. Dr. Curl, to my great surprise, advocates its cultivation, but its brief period of duration completely deprives it of value to the agriculturist.

This and the two preceding species are more abundant about Wellington than in any other locality in the colony.

Lepturus, sp.

A remarkable plant naturalized on shingly beaches, and distinguished by its flattened rachis. I have not been able to identify it with any species of which I possess descriptions, but can hardly doubt its being of exotic origin.

Anthistiria australis, Br.

In 1874 I observed the kangaroo grass growing on sandy soil in the Lower Rangitikei, and subsequently ascertained that it had been sown in the vicinity some years before, and was supposed to have died out; recently it was pointed out to me on Mount Victoria by one of the students of Wellington College. It is a valuable and nutritious grass, but cannot be expected to maintain its ground unless allowed to seed freely.

CATALOGUE OF NATURALIZED PLANTS

Observed in the Vicinity of Port Nicholson and other Localities in the Wellington Provincial District.

NOTE.—Those species not observed elsewhere in New Zealand are distinguished by an asterisk.

RANUNCULACEÆ.

Ranunculus sceleratus, L. An anonymous writer in the "Educational Gazette," vol. I., p. 83, states that this species is found on the Porirua road. I have not seen Wellington specimens.

acris, L. Kaiwarawara, etc.

repens, L. Common in most places.

bulbosus, L. Kaiwarawara.

* *hirsutus*, Curtis. Old Porirua road—"Educational Gazette," I., p. 83, anonymous; *R. bulbosus*, L., is probably mistaken for this species, which I have not seen in the colony.

parviflorus, L. The typical form is common about Wellington, Otaki, Hutt Valley, Wairarapa, etc.; it is easily distinguished from *R. australis*, Br., by its comparatively robust habit.

muricatus, L. Specimens supposed to have been collected near Wellington are in the herbarium of the Colonial Museum.

* *philonotis*, Retz. Evans Bay, Hutt Valley, Otaki.

* *Aquilegia vulgaris*, L. Ohariu; a garden outcast.

PAPAVERACEÆ.

* *Glaucium luteum*, L. Shingly shores of Port Nicholson; Lyall Bay; Island Bay; Makara; East Coast to Cape Palliser; supposed to have been introduced in the packing material of the patent slip machinery.

Eschscholtzia californica, Cham. By the sea, near Castle Point.

FUMARIACEÆ.

Fumaria muralis, Sonder. Common in cultivated land about Wellington; Wairarapa, etc.; Wanganui.

officinalis, L. Wellington; less frequent than the preceding species.

CRUCIFERÆ.

* *Matthiola sinuata*, Br. Castle Rock.

Cheiranthus cheiri, L. Wellington, etc.; a garden outcast.

Nasturtium officinale. Br.

var. *siifolium*. Abundant.

Barbarea præcox, Br. Wellington, etc.

Sisymbrium officinale, L. Abundant.
Brassica oleracea, L.
napus, L.
rapa, L.
Sinapis nigra, L.
arvensis, L.
Alyssum maritimum, L. Miramar; Pitone.
Cochlearia armoracia, L. A garden outcast.
Capsella bursa-pastoris, DC. Common.
Senebiera coronopus, Poiret.
S. didyma, Persoon. Spreading rapidly, and apparently more permanent in its hold than *S. coronopus*.
Lepidium ruderale, L. Abundant, widely diffused by sheep.
Raphanus sativus, L. Abundant in many places, especially on the railway line between Kaiwarawara and Pitone.

RESEDACEÆ.

* *Reseda luteola*, L. On sand-hills below the block-house, Wanganui.

VIOLACEÆ.

Viola odorata, L. Ohariu; possibly planted.
tricolor, L. An occasional outcast from gardens.
β. arvensis. Cultivated land, etc.

VITACEÆ.

Vitis vinifera, L. Occasionally found near the sites of abandoned homesteads.

CARYOPHYLLEÆ.

Silene quinquevulnera, L. Wellington; Hutt; East Coast; Wairarapa; Lower Rangitikei; Wanganui, etc.
* *noctiflora*, L. Karori Road; Wellington.
* *Lychnis coronaria*, L. Karori Road; Porirua Valley; etc.
Cerastium glomeratum, Thuill.
triviale, Link.
Stellaria media, With.
Arenaria serpyllifolia, L. Near Wellington; East Coast.
Sagina apetala, L. Mount Victoria; Miramar; Hutt, etc.
procumbens, L. Common about Wellington; Rimutaka Mountains; Wairarapa.
Spergula arvensis, L. Wellington; Wairarapa; etc.
Spergularia rubra, St. Hilaire. Thorndon; Miramar.

Polycarpon tetraphyllum, L. Common throughout the district. A remarkable variety forming hemispherical masses of deep green foliage, leaves always opposite, and solitary axillary cymes, with less conspicuous bracts than in the ordinary form, is abundant on the sands near Cape Palliser.

HYPERICINEÆ.

Hypericum androsæmum, L. Happy Valley; Karori; Ohariu; etc.
perforatum, L. Karori; Porirua; Wairarapa; etc.
humifuscum, L. Near Castle Point.

MALVACEÆ.

Malva rotundifolia, L. Wellington; Wairarapa, etc.; Foxton; Wanganui.
Lavatera arborea, L. An occasional garden escape.

LINEÆ.

Linum usitatissimum, L. Near an old ford of the Ruamahunga, Haurarangahau, plentiful; Wairarapa.

GERANIACEÆ.

**Geranium robertianum*, L. Tinakori Hill; Kaiwarawara.
Pelargonium quercifolium, Aiton. A garden escape.
Erodium cicutarium, L.
var. *triviale*
var. *pilosum*. Wellington; East Coast; Wairarapa; Wanganui.

SAPINDACEÆ.

Melianthus major, L. A garden escape, but able to maintain its position when not disturbed by man.

LEGUMINOSÆ.

Ulex europæus, L.
Cytisus scoparius, Link. Common about Wellington and other places.
hirsutus, L. (?) Karori, Wairarapa, Wanganui, and other places. Occasionally planted for garden fences, etc.
Medicago sativa, L. An agricultural escape, but, except on calcareous soils, appears to die out in a few years.
lupulina, L.
denticulata, Willd. The black and toothed medicks are alike frequent throughout the district; the first is a valuable fodder plant; the toothed medick is useful in spring, but its twisted, burr-like legumes are anathematized by the wool-grower.
maculata, Sibth. Near Wellington.
Melilotus officinalis, L.
arvensis, Wallroth.

**Trifolium incarnatum*, L. Porirua—*H. B. Kirk!*

pratense, L.

medium, L.

**striatum*, L. Kilbirnie—*H. B. Kirk!*

glomeratum, L. Mount Victoria.

repens, L.

procumbens, L. Near Wellington; Wairarapa; East Coast; Wanganui.

minus, Sm.

resupinatum, L. Mount Victoria—*H. B. Kirk!*

Lotus corniculatus, L. Near Castle Point.

Robinia pseudacacia, Willd. A mere garden or plantation escape, increasing rapidly by suckers where undisturbed.

Vicia tetrasperma, Mœnch.

var. *gracilis*. Kaiwarawara—*H. B. Kirk!*

hirsuta, Koch.

sativa, L.

angustifolia, Roth.

**Lathyrus grandiflorus*, L. A garden escape, near the Hutt.

odoratus, L. Karori-road, etc.

Rosaceæ.

Amygdalus persica, L.

Primus cerasus, L. The peach and cherry are often found on the sites of abandoned homesteads, but do little more than maintain the position in which they were placed by man.

Rubus discolor, Weihe and Nees.

rudis, Weihe. Happy Valley; Ohariu; etc., etc.

idæus, L.

Fragaria vesca, L.

Potentilla reptans, L. Tinakori Road; a garden weed.

Alchemilla arvensis (L.) Lyall Bay—*H. B. Kirk.*

Poterium sanguisorba (L.) Hills near Castle Point.

Acæna ovina, L. Mount Victoria, etc.—*H. B. Kirk!* Porirua—*J. Buchanan!*

Rosa rubiginosa, L.

canina, L.

var. *sarmentacea*. Near Wellington; very rare.

multiflora Thunb. Taita; Upper Hutt; etc., etc.

Saxifrageæ.

Ribes grossularia, L. Not unfrequent in forests—Makara; Ohariu; Wairarapa—probably originating from seeds carried by birds.

ONAGRARIEÆ.

Œnothera stricta, L. Wairarapa; Wanganui.

LYTHRACEÆ.

Lythrum hyssopifolia, L. Wellington; East Coast; Wairarapa; Marton; Wanganui, etc.

UMBELLIFERÆ.

Conium maculatum, L. Te Aro.

Apium graveolens, L. An occasional garden escape; soon dying out.

Petroselinum sativum, Hoffm.

Fœniculum vulgare, Gærtn.

Pastinaca sativa, L.

Daucus carota, L. The parsley, fennel, parsnip, and carrot are common garden escapes; the fennel, and in some cases parsley, are increasing.

CAPRIFOLIACEÆ.

Sambucus nigra, L.

**Leycesteria formosa*, Wallroth. Karori; Pakuratahi. A garden escape, which, if left undisturbed, would increase rapidly. A large patch formerly existed on the site of the new reservoir.

RUBIACEÆ.

Galium aparine, L.

Sherardia arvensis, L.

VALERIANEÆ.

Centranthus ruber, DC. Wellington; Karori; Wairarapa.

DIPSACEÆ.

**Dipsacus sylvestris*, L. On the hills between the Tinakori-road and Kaiwarawara; Makara Valley; Porirua Valley.

Scabiosa atropurpurea, L. Karori; Wairarapa. A garden escape.

COMPOSITÆ.

Centaurea solstitialis, L. Evans Bay; East Coast; Foxton.

Carduus lanceolatus, L.

marianus, Gærtner. One of the commonest plants about Wellington; Wairarapa, etc.; comparatively rare.

arvensis, Curtis. Miramar—*J. Buchanan*. Probably extirpated.

Erigeron canadense, L. The Hutt; Belmont, etc.; East Coast. Not nearly so abundant as in Auckland.

Bellis perennis, L.

Anthemis arvensis, L. East Coast, etc.

cotula, L. Karori, etc.

Achillea millefolium, L.

Matricaria inodora, L.
parthenium, L.
Chrysanthemum segetum, L.
leucanthemum, L.
Artemisia absinthium, L. Porirua.
Senecio vulgaris, L.
sylvaticus, L. Wanganui.
scandens, L. A garden escape. Karori and other places.
Cryptostemma calendulacea, Br. Wanganui.
Lapsana communis, L.
Arnoseris pusilla, Gærtn. East Coast, etc.
Cichorium intybus, L. Near Greytown.
Hypochæris glabra, L. Common about Wellington, etc.
radicata, L.
Helminthia echioides, Gærtn.
Thrincia hirta, Roth.
Apargia autumnalis, Willd.
Taraxacum officinale, Wiggers.
Crepis virens, L.
Sonchus asper, Hoffm.
Xanthium spinosum, L. At the foot of the Paikakariki Hill.

CAMPANULACEÆ.

* *Campanula trachelium*, L. A garden escape; Ohariu.

APOCYNEÆ.

Vinca major, L. Taita; Upper Hutt; Wairarapa, etc.

GENTIANEÆ.

Erythræa centaurium, Pers. Makara; Porirua; Wairarapa.

BORRAGINEÆ.

Borrago officinalis, L. A garden escape. Johnsonville.
Myosotis strigulosa, Rehf. Wellington; East Coast; Wairarapa.

SOLANEÆ.

Solanum tuberosum, L.
indicum, L.
Physalis peruviana, L.
Nicotiana tabacum, L.
Lycium barbarum, L. Upper Hutt; East Coast.

SCROPHULARINEÆ.

Verbascum thapsus, L.
blattaria, L.

Mimulus luteus, L. Abundant in swampy or moist places about Wellington; Karori: Ohariu; Wairarapa.

moschatus, L. Kahumingi; East Coast.

Digitalis purpurea, L. Ohariu.

Veronica agrestis, L. Not unfrequent in cultivated land. Makara; Te Ore, etc.

buxbaumii, Ten. Karori-road; East Coast.

arvensis, L.

serpyllifolia, L.

LABIATÆ.

Mentha dentata, L. Horokiwi Valley.

viridis, L. Karori; Kaiwarawara; Ohariu; Wairarapa.

Stachys arvensis, L. Common in cultivated ground.

palustris, L. Wanganui.

* *Nepeta glechoma*, Benth. Wanganui.

Marrubium vulgare, L. Foxton; Wairarapa, etc.

Prunella vulgaris, L.

* *Lamium purpureum*, L. Cultivated ground. Wanganui.

VERBENACEÆ.

Verbena officinalis, L. Porirua; Pakuratahi; Wairarapa.

PRIMULACEÆ.

Anagallis arvensis, L.

PLANTAGINEÆ.

Plantago major, L.

media, L. A single specimen observed near the outlet of Adelaide-road drain, Te Aro beach.—*J. Buchanan*.

* *varia*, R. Br. This plant has for several years maintained a struggling existence in Boulcott-street, Wellington, but appears doomed to speedy extinction from the progress of street improvements.

lanceolata, L.

coronopus, L. Te Aro beach; Kilbirnie.

POLYGONEÆ.

Polygonum persicaria, L. Near Wellington.—*J. Buchanan!*

convolvulus, L. Cultivated land. Te Ore.

Rumex obtusifolius, L.

pulcher, L. Not unfrequent about Wellington; the Hutt, etc.

* *maritimus*, L. The "golden dock" is stated, on anonymous authority in the "Educational Gazette," I., p. 46 (1874),

to occur at Pipitea Point, I cannot but think erroneously, as so conspicuous a plant would, of necessity, have attracted the attention of local botanists.

**palustris*, Sm. Pipitea Point—*J. Buchanan!* (1872); now extinct.

crispus, L.

sanguineus, L. Te Aro, etc.

β. viridis.

conglomeratus, Murr. Pipitea Point.—*Anonymous* in "Educational Gazette," I., p. 146. It is probable that starved specimens of *R. viridis* have been mistaken for this.

acetosella, L.

AMARANTHACEÆ.

Amaranthus blitum, L. A fugitive weed in gardens; rare. Wellington.

CHENOPODIACEÆ.

Beta cycla, Auct. Hutt-road.

Chenopodium album, L.

viride, L.

murale, L.

Atriplex angustifolia, Sm.

erecta, Huds.

* *deltoidea*, Bab. Te Aro; Evans Bay.

EUPHORBIACEÆ.

Euphorbia helioscopia, L. Cultivated land; Pitone, etc.

peplus, L.

lathyris, L. A garden escape. The Hutt.

URTICEÆ.

Urtica urens, L. Foot of Paikakariki Hill.

dioica, L. Near Wellington.

Ficus carica, L. Occasionally found on the sites of abandoned gardens.

CANNABINEÆ.

* *Humulus lupulus*, L. Happy Valley; near Porirua, etc.

IRIDEÆ.

Sisyrinchium chilense, Hook. Hills about Wellington.

Iris germanica, L.

susiana, L. Not unfrequent on the sites of abandoned homesteads, etc.

* *pseudacorus*, L. The Hutt.

AMARYLLIDEÆ.

Agave americana, L. Near deserted homesteads, etc.

AROIDEÆ.

Richardia africana, Kunth. The Hutt; probably planted.

LILIACEÆ.

Asparagus officinalis, L. Solitary plants are sometimes found originating from seed carried by birds; near Khandallah; Te Ore. It can scarcely be expected to maintain its position, except perchance in maritime localities.

GRAMINEÆ.

Digitaria sanguinalis, Scop. Near Castle Point.

Phleum pratense, L.

Phalaris canariensis, L.

arundinacea, L., *β. picta*. By a tributary of the Waiwetu; probably planted.

Anthoxanthum odoratum, L.

Agrostis canina, L.

alba, L.

β. stolonifera.

Gastridium lendigerum, Gaud. Miramar—*J. Buchanan.*

Polypogon monspeliensis, Desf. Evans Bay; Miramar, etc.

Lagurus ovatus, L. Miramar—*J. Buchanan.* I have not seen specimens.

Psamma arenaria, R. and S. Extensively planted at Miramar, but does not increase by seed.

Cynodon dactylon, Pers. Formerly at Te Aro Beach, near the site now occupied by the kerosene store; Castle Point.

Aira caryophyllea, L.

Avena sativa, L.

Arrhenatherum avenaceum, Beauv. Kaiwarawara, etc.

Holcus lanatus, L.

mollis, L.

Dactylis glomerata, L.

Poa annua, L.

pratensis, L.

trivialis, L. Frequent about Wellington and other places.

Glyceria fluitans, Br. Wellington, abundant; Karori; Makara, etc.; Hutt Valley; less frequent in the Wairarapa.

Briza minor, L.

maxima, L. Plentiful about Wellington, Evans Bay, etc.

Festuca sciuroides, Roth.

Bromus sterilis, L.

mollis, L.

racemosus, L. Pollhill Gully, etc.

commutatus, Schrad.

arvensis, L. Miramar—*J. Buchanan.* I have not seen specimens.

unioloides, Humb.

Cynosurus cristatus, L. More generally naturalized in the Wellington district than any other.

Triticum sativum, L.

Lolium perenne, L.

italicum, A. Braun.

temulentum, L.

β. arvense. East Coast and Wairarapa.

* *Lepturus*, sp. Common on shingly beaches from Cape Palliser to Lowry Bay, and from Cape Terawiti to Miramar.

Hordeum vulgare, L.

murinum, L. Common near the sea; rare inland.

Anthistiria australis Br. Lower Rangitikei; Mount Victoria.

NOTE.—*Streptachne ramosissima*, Trin., discovered by Mr. Travers in the South Island, occurs in a naturalized condition at Miramar.

Panicum imbecille, Trin., occurs in an indigenous condition in the northern part of this island, and has become naturalized in the botanic gardens.

ART. LII.—*On the New Zealand Species of* Phyllocladus. By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 17th November*, 1877.]

WITH the exception of the kauri the celery-leaved pines are the most attractive members of our indigenous coniferæ; their striking appearance at once arrests the attention of the planter, while the singular structure of their foliaceous appendages gives them special interest in the eyes of the botanist. Only five species are known, three of which are found in New Zealand, in many localities forming a marked feature in the vegetation. Of the remaining species one is confined to the lofty mountains of Borneo, another which is closely allied to, if not identical with, the New Zealand *P. alpina*, is found in Tasmania, and, I believe, also in New Caledonia.

The species vary from dwarf alpine shrubs as *P. alpina* to handsome trees as *P. trichomanoides*, seventy feet in height, with a trunk from two to three feet in diameter, and affording timber of great strength and durability. All the species have the branches more or less arranged in whorls. *P. glauca* is invariably diœcious, *P. trichomanoides* invariably monœcious, *P. alpina* must be considered monœcious also, but there is reason to believe that this species shows a tendency to assume a diœcious character; this, however, has not been proved.

True leaves are only produced in the young state; they disappear before the plant attains its third year; rudimentary scale-like leaves, from the axils of which the broad foliaceous organs are produced, are developed on the branches, but soon fall off. The broad fern-like foliaceous expansions, which take the place of true leaves, are by some termed "cladodia," by others "phyllodia," according to the point of view from which they may be regarded, whether as consisting of abortive flattened branches when the former term is applied, or of a flattened and expanded petiole, or of coherent leaves, or of an expanded combination of leaves and petiole—to either of which the term phyllodia is applied. As, however, these organs develope flower-buds, a process of which true leaves are incapable, it is evident that they cannot be regarded merely as connate leaves, or any modification of leaves and petioles, so that the term cladodia is most closely applicable.

The cladodia are thick and coriaceous, more or less rhomboid in shape, with the upper margin more or less toothed, lobed, or erose; the lateral veins radiate from a central vein outwards, so that the organ bears a general resemblance to the pinnule of a large species of *Adiantum*. In *P. glauca* and *P. trichomanoides* the cladodia are arranged distichously on a rachis consisting of a peculiarly modified branch, and present the appearance of an ordinary pinnate leaf with alternate leaflets, forming in fact pinnate cladodia, the greater portion of which fall off when the lateral expansions have performed their function. But in *P. trichomanoides* during autumn or early spring a whorl of new cladodia is developed at the apex of an old rachis, the lateral cladodes of which soon after drop off and the rachis becomes a permanent branch. In the spring, male amenta are produced at the apex of a branch and surrounded by a whorl of cladodia with the lateral expansions greatly reduced in size and carrying female cones. This arrangement, however, is liable to several unimportant modifications. In *P. glauca* the process is somewhat different; a terminal rachis becomes elongated and thickened, assuming the character of a true branch; in the following spring the axis is slightly elongated and densely clothed with recurved rudimentary leaves surmounted by a whorl of large cladodia, which carry female flowers instead of lateral cladodia in the lower part of the rachis.

The female flowers are arranged in amenta, which are one-flowered in *P. trichomanoides*, two- to four-flowered in *P. alpina*, and from ten- to twenty-flowered in *P. glauca*. Each ovule is imbedded between two modified leaves, which become thickened and fleshy as the fruit approaches maturity, and in *P. glauca* at length woody. In that species the numerous nuts are arranged in slightly interrupted spirals, and in all the species the nuts are much compressed, and have the lower part invested by an arillode, which is most conspicuously developed in *P. alpina*.

No diagnosis of *P. glauca* has yet been published in the colony, although its discovery was announced in the first volume of our "Transactions."* A short time previously it had been described in France from young cultivated specimens supposed to have been obtained in Tasmania or raised from Tasmanian seed. I now give a diagnosis drawn from fresh specimens, and have added new descriptions of the other indigenous species, embodying all the information I have been able to obtain respecting them.

Phyllocladus glauca.

Carriere, Coniferes, p. 502; Gordon, Pinetum, p. 140; Henk. and Hochst., Nadelhölz, p. 173.

Phyllocladus trichomanoides, Don; *β. glauca*, DC., Prodromus, XVI., part ii., p. 498.

A diœcious tree, 20–40 feet high, trunk 12–18 inches in diameter, branches stout; young leaves linear, glaucous beneath, crowded; scale leaves deciduous, recurved; cladodia distichous on a rachis 5–12 inches long; one or two at the end of a branch becoming produced into true branches, each developing a whorl of cladodia somewhat smaller than the original. Lateral cladodia glaucous when young, exceedingly coriaceous, rhomboid, or obliquely ovate-cuneate, deeply toothed or lobed; teeth obtuse. Flowers: male—amenta numerous, 10–20 at the tips of a branch, on stout radiating peduncles, including the peduncles about two inches long; scales obtuse; female—amenta distichous, shortly peduncled, 4–6 on each side of the lower part of a rachis; ovoid, half-an-inch long; nuts 10–20, much compressed.

Hab. North Island: Maungatawhiri—*R. Mair!* Great Omaha (1865), Great Barrier Island (1867), Cape Colville, Thames Gold Field—*T. K.*; Wairoa (East)—*W. J. Palmer.*

This species ascends from the sea level to 2,800 feet, attaining its largest dimensions in sheltered localities at the higher levels.

This is the toa-toa of the Maoris north of the Waitemata, but according to Colenso, the East Coast natives south of the Thames apply that name to the next species. Settlers in the South Island often apply it to *P. alpina.*

Although this species is glaucous in the young state, the specific name is not so appropriate as it would be to *P. alpina.*

The large size of the cladodia and the many-seeded fruit at once distinguish this fine species from its congeners; to these marked distinctive features may be added its diœcious character and long peduncled male catkins, which are more numerous than in either *P. trichomanoides* or *P. alpina.* The female catkins are not borne on the margins of cladodia, but

* Trans. N.Z. Inst., I., p. 149.

on short peduncles which occupy their place and are confined to the lower part of the rachis. The nuts are arranged in slightly interrupted spirals.

The young leaves disappear about the second or third year. The mature plant bears some resemblance to the ginko, *Salisburia adiantifolia.*

Phyllocladus trichomanoides.

Don in Lamb. Pin., ed. 2, App.; Rich., Con., p. 129, t. 3; A. Cunn., Prodr.; Hook., Ic. Plant., t. 549, 550, 551; Endl., Conif., p. 225; Hook. fil., Fl. N.Z., I., 235—Handbook, p. 952; Carr., Conif., p. 449; Gord., Pin., p. 142; Parl. in DC. Prodromus, XVI., pt. II., p. 498.

P. rhomboidalis, A. Rich., Fl. Nov. Zel., p. 368. (not of C. L. Rich.)

A monœcious tree 60 feet high or more, trunk 2–3 feet in diameter, branches whorled, branchlets slender; young leaves linear, crowded, scale leaves acuminate, rachides 1–3 in. long, whorled, cladodia distichous, coriaceous, lobed or toothed, lobes truncate, erose. Fl.: male—amenta in terminal fasciculi of from 5 to 10, shortly pedicelled, scales acuminate; female—amenta solitary on the margin of cladodia, which are often reduced to mere peduncles, one-flowered, cup fleshy, nut much compressed.

Hab. North Island. Frequent in forests from the North Cape to Lake Taupo; less frequent southwards.

South Island: Mr. Travers informs me that this species occurs in the Maitai Valley, Nelson, where it attains the height of forty feet. I have not seen South Island specimens.

This species ranges from the sea-level to 2,500 feet.

It is the tanekaha of the northern natives, and, according to Colenso, the toa-toa of the natives south of the Thames.

It is easily distinguished by its slender twiggy branches and single seeded fruit. It is the loftiest of all the celery pines, in some cases attaining the height of seventy feet, and affording a timber of great strength and durability, capable of being worked with the greatest ease. The bark is valued for tanning and yields a black dye which has long been utilized by the natives.

The young leaves disappear the second year, and their transition to cladodia is somewhat abrupt; from the axils of the uppermost leaves pinnate or pinnatifid leaf-like organs are produced, the first two or three being about an inch in length with the lateral segments deeply laciniate or pinnatifid, but immediately above these others of larger dimensions are quickly produced, three to four inches in length, with the lateral segments acute and deeply laciniated, membranous, and glaucous beneath. These gradually pass into cladodia, which do not become coriaceous until the plant developes its second or third whorl of branches.

In an account of the building timbers of Otago,* Mr. Blair states that

* Trans. N.Z. Inst., IX., p. 163.

this species is common "at high altitudes on the west coast, but rare on the east coast of Otago," and that "it grows to a height of from fifty to sixty feet, with a straight clear trunk two to three feet in diameter for two-thirds of the distance." He adds, "A few trees are to be met with in the vicinity of Dunedin," etc. Unless Mr. Blair has been led astray by the native name tanekaha being misapplied to *P. alpina*, it is difficult to account for this error, as the present species does not occur in Otago, and *P. alpina*, although plentiful in the district mentioned by him, is usually little more than a bushy shrub, and never attains dimensions at all approaching those of *P. trichomanoides.*

Phyllocladus alpina.

Hook. f., Fl. N.Z., I., p. 235, t. 53—Handbook, p. 260; Carr., Conif., p. 501; Gord., Pin., p. 139; Henk. and Hochst., Nadelhölz, p. 373.

P. trichomanoides, Don, var. *alpina*; Parl. in DC. Prodromus, XVI., pl. II., p. 499.

A monœcious shrub or small tree, 5–20 feet high; branches numerous, short, stout; cladodia crowded glaucous, very coriaceous, varying greatly in size—half an inch to an inch in length,—cuneate, or linear rhomboid, or linear oblong, almost entire or variously lobed or toothed, margin erose. Fl.: male—in terminal fasciculi of 3–5 small, shortly peduncled catkins; female—on the margins of reduced cladodia or at the base of others; ovules two to four; cup fleshy, and largely compressed.

Hab. North Island: Ruahine Mountains—*Colenso;* Tongariro—*Bidwill.*

South Island: Common on the mountains; sea level near Hokitika, etc.,—*T.K.* Ascends to 5,000 feet near Nelson (according to *Bidwill.*)

The settlers in the South Island term this plant indifferently tanekaha and toa-toa.

Easily distinguished by its bushy habit, its crowded simple cladodia and 3-4-seeded fruit; the nuts are inverted, with a membranous arillode which is developed considerably above the margin of the fleshy cup.

The trunks of this species are used for levers by bushmen on the West Coast, but are rarely of sufficient dimensions to be valued for other purposes, except perhaps as fencing rails, for which their strength and durability would be well adapted. In the Handbook of the N.Z. Flora the trunk is said to be "sometimes two feet in diameter." I do not remember to have seen a specimen more than one-third of that size, and Mr. Buchanan informs me that his experience is the same.

The young state of this plant closely resembles that of *P. glauca*, but the first formed cladodia are shorter, broader, and more coriaceous in all stages; it is easily distinguished from that species and from *P. trichomanoides*, but I have no doubt that it will ultimately prove identical with the Tasmanian *P. rhomboidalis*, Rich., (*P. aspleniifolia*, Lab.), for although

specimens from alpine habitats look very different to that plant, fruited specimens from low levels are undistinguishable. I have not had the opportunity of examining male catkins of *P. rhomboidalis*, but believe they are longer and more slender than those of our plant.

Art. LIII.—*A revised Arrangement of the New Zealand Species of* Dacrydium, *with Descriptions of new Species.* By T. Kirk, F.L.S.

Plates XVIII.—XX.

[Read before the Wellington Philosophical Society, 2nd February, 1877.]

Amongst the Protean plants of New Zealand few genera are in a more unsatisfactory condition than *Dacrydium*. The unisexual character of the species, the difficulty of procuring good flowering and fruiting specimens from the same individuals, and the local and difficult habitats of several forms, have led to great perplexity, through the combination of distinct species and a want of precision in the limitation of those admitted. It is hoped that the present paper will tend to remove these difficulties, although it must not be looked upon as final, since we may fairly expect that other species will yet be discovered in the mountain districts of the central portion of the North Island and the south-western portion of the South.

Although my attention has been specially directed to this genus for the last ten years, it was not until the commencement of last year that I was able to solve the difficulties by which it was surrounded, and to lay down more precise limitation for the recognized species with descriptions of others new to science. I am pleased to say that Sir Joseph Hooker and myself have independently arrived at the same conclusions, except with regard to a single species, and I take the opportunity of expressing my thanks to him for his valued notes, and for the opportunity so kindly afforded me of comparing several of the original specimens of Bidwill, Lyall, Colenso, and Hector, with my own collections.

The New Zealand species form two natural groups—the first distinguished by the young plants possessing terete spreading leaves which pass by very gradual transition, sometimes extending over a number of years, into the abbreviated and closely imbricated condition, characteristic of the mature state. With one exception all the species of this group are characterized by solitary fruit.

In the second group the young plants exhibit flat, linear, spreading leaves, which for the most part pass abruptly into the quadrifariously imbricated leaves characteristic of the fruiting state; leaves of an intermediate kind are

rare, and when produced are merely the linear leaves diminished in size. In some specimens of *D. kirkii* there is reason to believe that this transition is not effected until the tree is thirty or forty years old. In *D. bidwillii* this change is effected by the end of the second or third year at most, although occasionally branches exhibiting the early form of leaf are produced on the trunk and primary limbs of old specimens. *D. colensoi* requires an intermediate period, and on old specimens of its most robust mountain form the early leaf state is rarely seen. The members of this group exhibit a strong tendency to produce aggregated fruit which attains its maximum in *D. kirkii.*

The species vary greatly in habit and dimensions. *D. laxifolium* is perhaps the most diminutive pine known; pigmy specimens may be covered by a crown-piece. *D. bidwillii* is a dwarf, often prostrate, shrub. *D. cupressinum* is commonly 80 feet high or more, with a trunk 2–4 feet in diameter, and weeping branches. *D. colensoi* is a small tree with short trunk and heavy round head. *D. kirkii* is a noble species, 60–80 feet high, with conical head and peculiar aspect from the lower spreading branches having leaves resembling those of a *Picea*, while the upper fastigiate branches have abbreviated cypress-like foliage.

Several species are of great importance from their economic value. *D. cupressinum*, the rimu or red pine, yields the greatest portion of the marketable timber produced in the South Island. It is of great value for all inside work, and is largely used for building purposes, but, although of great strength, is not durable when exposed. It is largely used in the manufacture of furniture. *D. westlandicum*, the Westland or white silver pine, is of great durability, probably owing to the large quantity of oily and resinous matter which it contains. It is exported from Westland to a considerable extent, and fetches a higher price in the Westland markets than any other timber except kauri. *D. intermedium*, the yellow silver pine, is considered still more durable, and is highly valued on the west coast of the South Island. *D. colensoi*, the yellow pine or tar-wood of the Otago settlers, is another species of great durability, although of rather small dimensions. *D. kirkii*, the manoao of the North Island, affords perhaps the most durable timber of all: small trunks the thickness of a man's arm, used as palisades in a Maori pa known to have been constructed ninety years ago, are said to be still perfectly sound and good. This species was sufficiently plentiful on the Great Barrier Island to admit of its conversion a few years ago, and the timber was placed in the Auckland market under the name of Barrier pine; but, owing to the removal of the machinery, the supply has ceased.

KEY TO THE SPECIES.

A. Leaves of young plants, terete, spreading, passing into the mature imbricating state by gradual transitions. Nuts solitary (except in *D. westlandicum*), not compressed.

1. Branches pendulous, mature leaves imbricating all round. *D. cupressinum.*
2. Branches erect, mature leaves triangular, 4-fariously imbricating. *D. intermedium.*
3. Branches erect, diœcious; nuts 1–3. *D. westlandicum.*
4. Branches prostrate, struggling, monœcious. *D. laxifolium.*

B. Leaves of young plants linear, flat, abruptly changing into the mature state; nuts 1–5, compressed.

5. Erect, recumbent, or prostrate, leaves of young plants sessile; nuts 1–2. *D. bidwillii.*
6. Erect, young leaves shortly petioled; nuts 1–2; mature leaves 4-fariously imbricating. *D. colensoi.*
7. Erect, young leaves shortly petioled; nuts 1–5; mature leaves subcylindrical. *D. kirkii.*

1. *Dacrydium cupressinum.*

Solander in Forst. Plantis. Escul., p. 80: Prodr., p. 92; Don in Lamb. Pin., edit. 1, p. 93, t. 41; Rich., Conif., p. 16, t. 2, f. 3; A. Rich., Fl. Nov. Zel., p. 361; A. Cunn., Prodr. in Ann. Nat. Hist., I., p. 214; Endl., Con., p. 225; Hook. f., Flora of New Zeal., I., p. 233: Handbook of N.Z. Fl., p. 258; Carr., Conif., p. 486; De Candolle, Prodr., XVI., pars 2, p. 494.

Thalamia cupressina, Spreng., Syst. Veg., 3, p. 890.

A diœcious tree 60–80 feet high or more, trunk 3–5 feet in diameter, bark scaling, branches pendulous, pale green; leaves of young plants terete, lax, ascending, on older branches shorter, trigonous decurrent, imbricating all round, ¼ inch long; on mature branches shorter, subulate, curved, densely imbricating, $\frac{1}{12}$ inch long; male catkins not seen; nuts on the tips of curved branchlets, solitary, ovoid, ⅛ inch long, not compressed; involucral cups rarely fleshy.

Hab. Throughout New Zealand, ascending to 2,000 feet.

A handsome tree, affording valuable although not durable timber. Young trees up to 25 feet high, when not too crowded, form objects of exquisite beauty. Their pyramidal or conical habit, and their long slender pendulous pale green branches, present an aspect totally different from that of any other native tree. In old specimens the pyramidal habit has disappeared, the branches are spreading, the pendulous branchlets short, and the leaves more closely imbricated, so that although the aspect is still unique in the New Zealand forest, much of the elegance and grace of the early state is lost.

This species is most abundant on the west coast of the South Island, where it often forms a large proportion of the forests, but it attains its largest dimensions in the deep forests of the North Island.

It should be remarked that the recurved fertile branchlets are really erect, the branches on which they are borne being pendulous. Occasionally old specimens are found with erect or sub-erect branches drooping at the tips.

This species is the rimu of the Maoris and the red pine of the settlers.

2. *Dacrydium intermedium*, n. s.

A handsome diœcious tree 40 feet high or more; trunk, 1–2 feet in diameter; wood yellowish-red; leaves of young plants laxly crowded, terete, patent or erecto-patent, ¼ inch long, gradually becoming closely imbricated, 4-farious, triangular ovate, obtuse, keeled. Male catkins short, ovoid, terminal. Nuts terminal, erect, solitary, elliptic, with a minute hooked apiculus and faint striæ; not compressed.

Hab. North Island: Hirakimata, Great Barrier Island; Cape Colville Peninsula, and Thames Gold-field to Te Aroha, 1,500–2,500 feet; Tongariro—*Grace* in Herb. Mus. Col.!

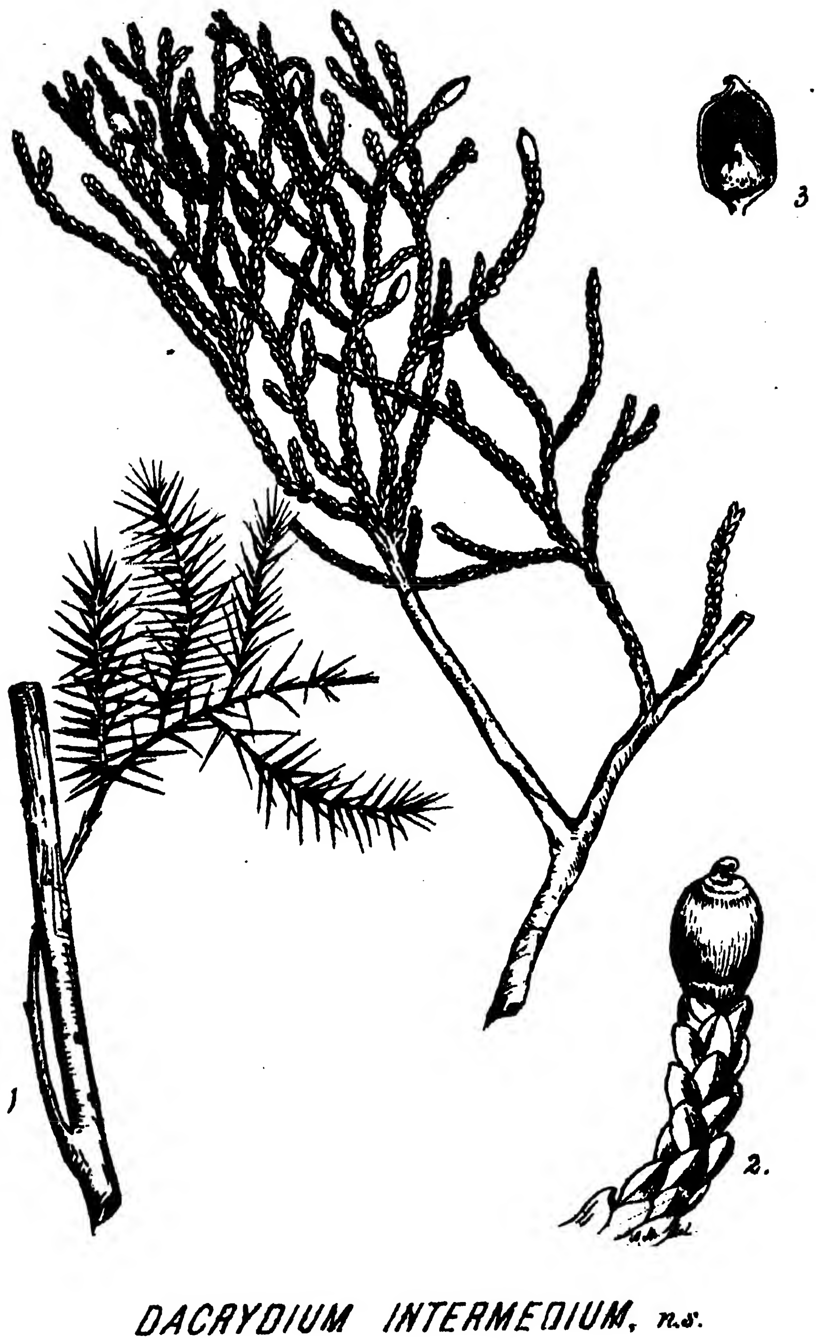
South Island: Dun Mountain, Nelson (collector's name not attached.) Herb. Mus. Col.! West Coast: Greymouth to Okarita (and probably southwards to Martin Bay.)

In the mature state the leaves resemble those of slender forms of *D. colensoi*, to which Sir Joseph Hooker is inclined to refer it; it is, however, separated from that species by the terete leaves of the young state and the uncompressed nut; the branches are less fastigiate than those of *D. bidwillii*, and less spreading than those of *D. colensoi*. The slender branches of young plants are slightly flexuous, and have some resemblance to those of *Podocarpus dacrydioides*, but are much larger; these are replaced by others similar to those of *D. cupressinum*, but stouter, which gradually diminish in size and widen into the broadly imbricating appressed state characteristic of the fruiting branches.

The West Coast plant is identified in the absence of fruit; the early leaves are more generally patent than is the case in northern specimens, the mature branches less strict, and the leaves less broadly keeled, differences which are probably due to situation alone; in both, the mature leaves are attached by broad bases. It was chiefly this character which led to its being considered an erect tree-form of *D. laxifolium*, in my account of the Botany of the Thames Gold Field.*

* Trans. N.Z. Inst., II., p. 95.

Dacrydium Westlandicum T. Kirk.



DACRYDIUM INTERMEDIUM, n.s.

This species is the yellow silver pine of Westland, where it is highly valued for its durability. It is occasionally utilized on the Thames Gold-field.

Plate XX. *Dacrydium intermedium.*

1. Sterile branch and leaves natural size.
2. Fertile branchlet enlarged.
3. Longitudinal section of nut enlarged.

8. *Dacrydium westlandicum.*

T. Kirk, MS.; Hook. fil., Icones Plantarum, t. 1218.

A diœcious tree 40–50 feet high, trunk $1\frac{1}{2}$–$2\frac{1}{2}$ feet in diameter, bark whitish, branches slender. Leaves of seedling plants terete, of early branches sub-terete, or trigonous, or subulate, decurrent, erecto-patent, compressed, $\frac{1}{4}$–$\frac{1}{2}$ inch long. Fruiting branchlets very slender, $\frac{1}{20}$–$\frac{1}{15}$ inch in diameter; leaves rigid, broadly triangular, compressed, carinate, slightly imbricate, obtuse. Male catkins terminal, solitary, oblong, $\frac{1}{15}$–$\frac{1}{10}$ inch long. Nuts (immature) solitary, or 1–3, $\frac{1}{15}$–$\frac{1}{10}$ inch long, obtuse, not compressed.

North Island: Whangaroa—*Hector!*; Great Barrier Island—*J. Springall* and *T. Kirk* (1871).

South Island: Greymouth to Okarita (in all probability extending northward to the mouth of the Buller and southwards to Martin Bay); not observed further inland than the Ahaura plain.

In the young state this species closely resembles the preceding, but the leaves are slightly trigonous; the minute leaves of the fruiting branches, and the small obtuse nuts, which are usually two in number, distinguish the mature state from all other members of this section. The wood is white, dense, and extremely durable.

My first knowledge of this plant was from dried specimens in the young state received from Dr. Hector in 1869, and collected by him at Whangaroa. In 1871, Mr. Springall and myself collected young plants on one of the high ranges in the interior of the Great Barrier Island, but owing to the approach of night we were unable to search for trees. It was only on visiting the west coast of the South Island in January, 1877, that I was able to identify the young state of the northern plant with the present species, which, although long valued for the durability of its timber, and forming an article of export under the name of Westland pine, or white silver pine, had not come under the observation of botanists.

The early leaves have some resemblance to those of *Podocarpus dacrydioides*, but the plant is stouter, with longer and flexuous branches.

Plate XVIII. *Dacrydium westlandicum*, T. Kirk.

— Sterile branchlet.	2. Fertile branchlet, enlarged.
1. „ „ enlarged.	3. Nucule, enlarged.

4. *Dacrydium laxifolium.*

Hook. fil., Lond. Journ. of Bot., IV., p. 143; Iconos Plant., 815; Flora Nov. Zel., I., p. 234; Handbook of N.Z. Fl., p. 259; Carr., Conif., p. 487.

A weak prostrate shrub, with trailing stoms. Monœcious; branches few, straggling, 3–15 inches long. Leaves on young plants, linear, curved, spreading, $\frac{1}{3}$–$\frac{1}{5}$ inch long, gradually diminishing in size to $\frac{1}{12}$ inch, when they bocome slightly thickened and obtuse, at length laxly imbricated all round the branches, broadly ovate, keeled, $\frac{1}{20}$–$\frac{1}{25}$ inch long. Male catkins terminal on short branchlets, $\frac{1}{8}$–$\frac{1}{4}$ inch long, solitary elliptic, anthers 2. Female flowers solitary, terminal; nut conical, with a minute hooked apiculus. Involucral cup usually dry, sometimes dilated, fleshy, red.

α. *debilis.*—Branches few, straggling; leaves rarely imbricating.

β. *compacta.*—Branches numerous, short, strict; leaves imbricating; plant forming a compact mass.

North Island: α. Ruahine Range—*Colenso*: Tongariro—*Bidwill! Colenso, Hector!*

South Island: α. Nelson mountains—*Bidwill*; Black Hills, Canterbury, 4,000 feet—*Sinclair* and *Haast!*; high ground between Kumara and Marsden, Westland—*T. Kirk*: Upper Waimakariri and Arthur's Pass, 2,000–3,000 feet—*J. D. Enys* and *T.K.*; mountains above Lake Harris—*T.K.*; Otago—*Hector* and *Buchanan.* β. Otago—*J. Buchanan*, Herb. Mus. Col.!; mountains above Lake Harris—*T.K.*

The most diminutive pine known; fruiting specimens are sometimes only two inches high, usually from six inches to ten. South Island specimens are usually more or less glaucous, and rather more robust than those from Tongariro, collected by Dr. Hector. The latter moreover are destitute of imbricated leaves. In southern specimens both forms of leaf may be found on the same branch, and cases of reversion are not uncommon. When the involucral cup is fleshy, the fruit bears a great resemblance to that of *Podocarpus dacrydioides.*

At first sight the var. β. *compacta* appears a totally different plant, but is connected with the type by intermediate forms.

In his sketch of the botany of Otago, Mr. Buchanan remarks:—"This *(D. laxifolium)* is a very doubtful species, being difficult to distinguish from *D. colensoi*,"—an opinion in which I cannot concur. To me it appears a most distinct plant, easily recognized in all stages. The difficulty experienced by Mr. Buchanan and others has doubtless arisen from mixing small specimens of *D. bidwillii* with this species.

5. *Dacrydium bidwillii*, n.s.

Hook. fil., in litt.

A diœcious shrub, erect, spreading, or prostrate. Leaves on young plants linear, obtuse, crowded, sessile, flat, ascending, $\frac{1}{4}$–$\frac{1}{2}$ inch long; on

fruiting branches 4-farious, imbricated, coriaceous, triangular, keeled, obtuse. Male catkins slender, terminal solitary, anthers two, connective, obtuse. Nuts solitary or in twos, striate, compressed, keeled, obtuse; involucral cup sometimes resinous.

a. erecta.—Erect, main branches pyramidal or conical; linear flat leaves obscurely costate, fruiting branchlets very slender; male catkins produced in profusion.

β. reclinata.—Prostrate or reclinate, linear leaves with evident costa; fruiting branches stouter.

North Island: I have no certain knowledge of the occurrence of either form in this island, although there is reason to believe that var. *a.* occurs at Tongariro, and is probably not uncommon on the Ruahine and other mountains.

South Island: *a.* Nelson—*Bidwill* in *Herb. Hook!* Roto Iti 2,000 feet, Square Town—*T.K.*; Canterbury—*Sinclair* and *Haast*; between Greymouth and Okarita, Westland—*T.K.*; Dusky Bay, Otago—*Hector* in *Herb. Hook! β.* Dun Mountain, Nelson—Herb. Mus. Col. (but without collector's name); flats by the Thomas River, Upper Waimakiriri, Bealey Gorge, and Lake Misery, 2,000-3,000 feet—*J. D. Enys* and *T. Kirk*; West Coast of Otago—*Hector.*

This species is distinguished from its allies by its dwarf stature and sessile linear leaves, which are attached by broad bases. It varies considerably in habit and in the size of the quadrifarious leaves.

In var. *a*, the linear flat leaves, so far as my observations extend, are never found on plants more than six inches high; when dry, they are of a pale brown colour; those of var. *β.* of a reddish-black.

A number of remarkable specimens of var. *β.* occur on flats by the Thomas river, where they form hemispherical clumps 2-5 feet high and 10-20 feet in diameter; there are also densely crowded rings of young plants with open centres of similar diameter. In the oldest specimens the trunk is found to branch at the surface of the ground, the main branches being prostrate, from 5-10 feet in length and 5-6 inches in diameter, rooting at their extremities. When the trunk is injured, or when it decays, the branches gradually die away, leaving their rooted tips to form a ring of young plants, but usually erect secondary branches are given off along their entire length, and a compact clump is formed. In this form the linear leaves are seldom seen except on seedlings, rarely small branches bearing leaves of the early type are given off from bare places in the main arms. Plants of similar habit were observed in the Waimakariri, but not nearly so well developed, owing to the crowded vegetation by which they were surrounded. The ordinary form of this variety has reclinate or spreading branches.

At present the distribution of this species is imperfectly known from its having been confused with *D. colensoi*. A resinous plant, which must probably be referred here, is said to be plentiful in the Massacre Bay district.

6. *Dacrydium colensoi.*

Hook., Icon. Plant., t. 548; Hook. fil., Fl. Nov. Zel., I., p. 234: Handbook N.Z. Fl., p. 952; Endl., Conif., p. 226; De Cand., Prodr., 16, pars 2, p. 495.

Podocarpus (?) biformis, Hook., Icon. Plant., t. 544.

A diœcious tree 20–40 feet high, bark whitish, trunk 1–2 feet in diameter; leaves on early branches ¼-inch long, linear flat, obtuse, costate, spreading; on upper branches quadrifariously imbricated, short, triangular, or ovate oblong, stoutly keeled, obtuse, $\frac{1}{20}$–$\frac{1}{12}$ inch long. "Male catkins terminal, solitary sessile; anthers 4–6; connective obtuse; nut small on a horizontal resinous cup-shaped disk."

North Island: Tongariro and Ruahine Ranges—*Colenso.*

South Island: Nelson mountains, 5,000–6,000 feet (?)—*Bidwill;* Canterbury, 2,000–4,000 feet—*Haast:* Arthur's Pass, 3,000 feet—*T.K.*; Otago, 3,000 feet—*Hector* and *Buchanan;* descends to below 1,000 feet near Dunedin—*T.K.*

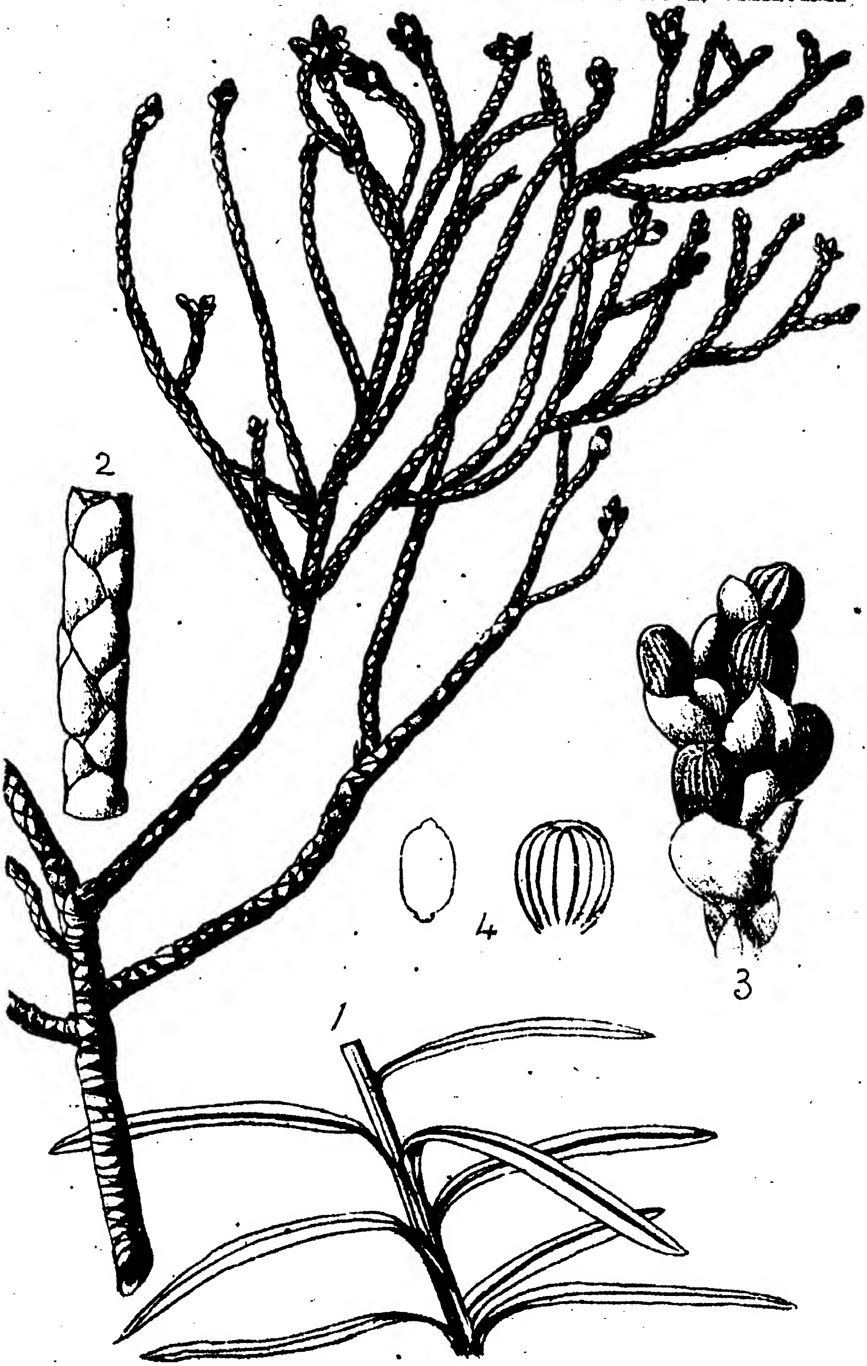
A round-headed tree with spreading ascending branches, varying greatly in the size of the mature leaves and thickness of the ultimate branchlets, which range from $\frac{1}{20}$–$\frac{1}{10}$ inch in diameter; in the more robust forms detached specimens may easily be mistaken for *Veronica tetragona* or *V. lycopodioides.* It differs from the preceding species in the arrangement of the branchlets, which are crowded at the ends of the branches and resemble an obtuse-topped kind of corymb. Not having had the good fortune to collect specimens in flower or fruit, I am unable to say if the nut is invariably solitary but suspect that it is not. From all forms of *D. bidwillii* it is distinguished by the larger petioled linear leaves, as well as the greater size and peculiar habit just described. According to Bidwill it occurs at the altitude of 6,000 feet on the Nelson Mountains, but I fear the height is over-estimated by 2,000 feet.

This species is the yellow pine or tar-wood of the Otago settlers; the wood is yellowish, dense, and durable, but can only be obtained in short lengths.

7. *Dacrydium kirkii.*

F. Muell. in De Cand. Prodr., vol. XVI., pars 2, p. 495; Hook. f., Icon. Plant., t. 1,219.

A diœcious tree, 40–80 feet high, 2–4 feet in diameter. Leaves of sterile branches 1–1¼ inch long, ¼ inch wide, linear, flat, sub-acute, shortly petioled, erecto-patent, coriaceous, shining, crowded or scattered, costa and veins distinct; margins slightly cartilaginous. Leaves of fertile branches



Dacrydium Kirkii, Hook f.

sub-cylindrical, closely imbricated, broadly rhomboidal, carinate, obtuse, with a membranous margin on the upper edge. Male catkins broadly ovate, $\frac{1}{8}$ inch long, terminal, solitary. Female terminal, involucral scales apiculate. Nuts 2–5 compressed, oval, obtuse, furrowed.

North Island: Whangaroa—*Hector, T. K.*; Cape Brett—*Colenso*; Whangarei—*R. Mair!*; Hokianga, Upper Wairoa, and Great Barrier Island—*T. Kirk*; Titirangi—*T. F. Cheeseman.*

A noble species, nearest to *D. colensoi*, but differing in the pyramidal or conical habit, in the large size of the lower leaves, the sub-cylindrical branches and aggregated nuts. The lower branches, sometimes to the height of 40 feet, are clothed with large linear leaves, giving the tree the appearance of a *Picea*, which is increased by its habit of growth. The lower branches are spreading, the upper fastigiate, and repeatedly dichotomously branched, with the branchlets forming semi-flabellate masses at the extremities. As in *D. bidwillii* and *D. colensoi*, the change from the spreading linear leaf state to the mature imbricated condition is most abrupt; in some specimens the tips of the lower branches exhibit appressed imbricated leaves, while the portions nearest the trunk are covered with large linear leaves, the intermixture of dimorphic foliage without intermediate forms presenting a singular and attractive appearance. The nuts are produced in greater abundance than those of any other New Zealand species, and often have their receptacles lined with a singular orange-coloured alveola. The nuts destitute of this lining are usually of less size.

The petioles of the flat linear leaves have a curious half twist.

This species is the manoao of the northern natives; its timber is of a reddish colour and of extreme durability.

I first collected this handsome species on the Great Barrier Island in 1867, and subsequently, under Dr. Hector's instruction, examined the Whangaroa habitat where he had previously discovered it. In papers on Northern Plants, and on the Botany of the Great Barrier Island, published in the first volume of "Transactions of the N. Z. Institute,"* I expressed a decided opinion as to its specific distinctness, but at that time I had not seen *D. colensoi*, and in deference to the opinion of Dr. Hector and Mr. Buchanan, who considered it a lowland form of that species, I refrained from giving a formal description. It was, however, published by the late Professor Parlatore the following year, under its present name in De Candolle's "Prodromus." It is, perhaps, the most strongly marked of all the New Zealand species.

Plate XIX. ***Dacrydium kirkii.***

1. Sterile branch and leaves.	**3. Female catkin enlarged.**
2. Fertile branch enlarged.	**4. Nuts enlarged.**

* Vol. I, pp. 141, 148.

ART. LIV.—*Notice of the Occurrence of a Variety of* Zostera nana, *Roth, in New Zealand.* By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 12th January,* 1878.]

UNTIL within the last twenty years few groups of plants have received less attention than the Marine Phanerogams, all the known species of which belong to the Monocotyledonous Orders *Hydrocharidaceæ* and *Naiadaceæ*. A complete list by Dr. Ascherson, of Berlin, appeared in 1874 in Neumayer's "Anleitung in Wissenschaftlichen Beobachtungen auf Reisen," containing twenty-six species arranged under eight genera.* The earliest record of any species having been found in New Zealand bears date so recently as 1867, when a *Zostera*, found in a flowerless condition in many places in the colony, was recorded in the "Handbook of the New Zealand Flora" as *Zostera marina*, L.—a species of wide distribution in the northern hemisphere—but the identity of our plant must be considered uncertain in the absence of flowers. I have now to record the discovery, in a flowering condition, of a second species, which, notwithstanding a slight departure from the normal characters, I identify with *Zostera nana*, Roth, and of which the following is a description.

Zostera nana, Roth, var. *muelleri*.

Z. muelleri, Irmisch.

Stem creeping, rather stout for the size of the plant, clothed with the dead bases of old leaves. Leaves linear, 3–6 inches long, $\frac{1}{16}$–$\frac{1}{12}$ inch wide, with about six nerves on each side of a midrib formed of two nerves in contact for their whole length, margin thickened; spathes 1–4, including the leafy portion 2–3 inches long, peduncles short, flattened; spadix rarely exceeding $\frac{3}{4}$ inch in length with inflexed membranous appendages on the margins; anthers about six on each side, ovules four; stigmas frequently exserted. Fruit faintly furrowed when mature.

Hab. North Island—Port Nicholson; on mud flats exposed at low water.

Our plant differs from the typical form in its more robust stem, clothed with the persistent bases of old leaves, leaves somewhat crowded and narrower, in the short, flattened peduncles, and in the rather larger fruit which agrees with the type in being faintly striated.

In Port Nicholson it is associated with the larger plant provisionally identified with *Z. marina*, the inflorescence of which must be sought in deep water.

* Not including *Ruppia* and those forms of *Zannichellia* and *Potamogeton* found in salt-water lagoons.

According to Dr. Ascherson, the typical form *Z. nana* has a wide distribution, occurring at the Canary Islands, Mediterranean, North Coast of Sicily, Smyrna, Black Sea, Caspian Sea, Portugal, Spain, France, British Islands, Holland, Denmark, Holstein, Japan, Cape of Good Hope, Port Natal, Nossi Beh.

Var. *muelleri* has been collected on the coasts of Chili, South and East Australia, Tasmania, and New Zealand.

Zostera tasmanica, G. v. Martens, is said to occur in New Zealand, but I do not know by whom collected. The plant intended is probably that referred to in the early part of this paper as *Z. marina*; but in any case the identification cannot be considered satisfactory in the absence of flowers, since it is possible that our plant may belong to *Phucagrostis*, which it closely resembles in habit.

ART. LV.—*Notice of the Occurrence of* Juncus glaucus, *L., in New Zealand.* By T. KIRK, F.L.S.

[*Read before the Otago Institute, 17th January, 1878.*]

In company with Captain J. Campbell-Walker I had the pleasure of discovering this interesting addition to our flora by the road-side between Hokitika and Ross, within a mile of the left bank of the Hokitika river. I had not time to make a detailed examination of the locality, but Mr. Shillitoe, who kindly went over it at my request, informs me that the plant occurs plentifully over a considerable area.

Juncus glaucus bears some resemblance to *J. communis*, Meyer, but is distinguished by its hard texture, interrupted pith, and glaucous striate rigid culms; the perianth segments are lanceolate and equal the capsule in length; the capsule is mucronate.

The culms are two to three feet in length, frequently drooping in large specimens.

In *J. communis*, var. *hexangularis*, the pith is sometimes slightly interrupted, but never to so great an extent as in *J. glaucus*, from which it may always be distinguished by the retuse capsule.

In all probability *Juncus glaucus* is not unfrequent on the west coast of the South Island. It is singular that this species, as well as *J. lamprocarpus*, Ehrhart, should not have been observed earlier. The latter species is abundant in the Hokitika district, extending southward to the Bluff and northward to Port Nicholson, but is not found on the eastern side of either island. In Taranaki and Auckland it is replaced by *Juncus holoschœnus*, Thunb.

The South Island is much richer in *Junceæ* than has hitherto been supposed. In addition to the species now mentioned, *Juncus capillaceus*, Hook. f., previously known only in a single habitat in Hawke Bay, has been found in the Southern Alps; *J. pauciflorus*, T. Kirk, at Broken River, and *J. involucratus*, T. Kirk, in the Amuri. In short, with the exception of *J. antarcticus*, Hook. f., restricted to the mountain tops of Campbell Island, and the northern *J. holoschœnus*, all the New Zealand species are found in what may be termed the middle portion of the South Island—the old provincial districts of Westland and Christchurch including the Amuri. We may fairly expect that other species will be discovered.

Art. LVI.—*Description of a new Species of* Hymenophyllum.

By T. Kirk, F.L.S.

Plate XXI.—B.

[*Read before the Wellington Philosophical Society, 1st December*, 1877.]

Hymenophyllum montanum.

Rhizome slender, wiry, creeping; fronds few, 2–3 inches long, glabrous, linear oblong or oblong lanceolate, bipinnatifid; stipes about 1 inch long, winged nearly to the base; rachis flexuous, winged, pinnæ in from 5–8 pairs, mostly alternate, spreading, about one-third of an inch long, cut nearly to the rachis into 2–4 spreading, linear, forked or bilobate segments. Involucres terminating the segments, small, oval, 2-lipped nearly to the base; lips deeply toothed or jagged; receptacle included.

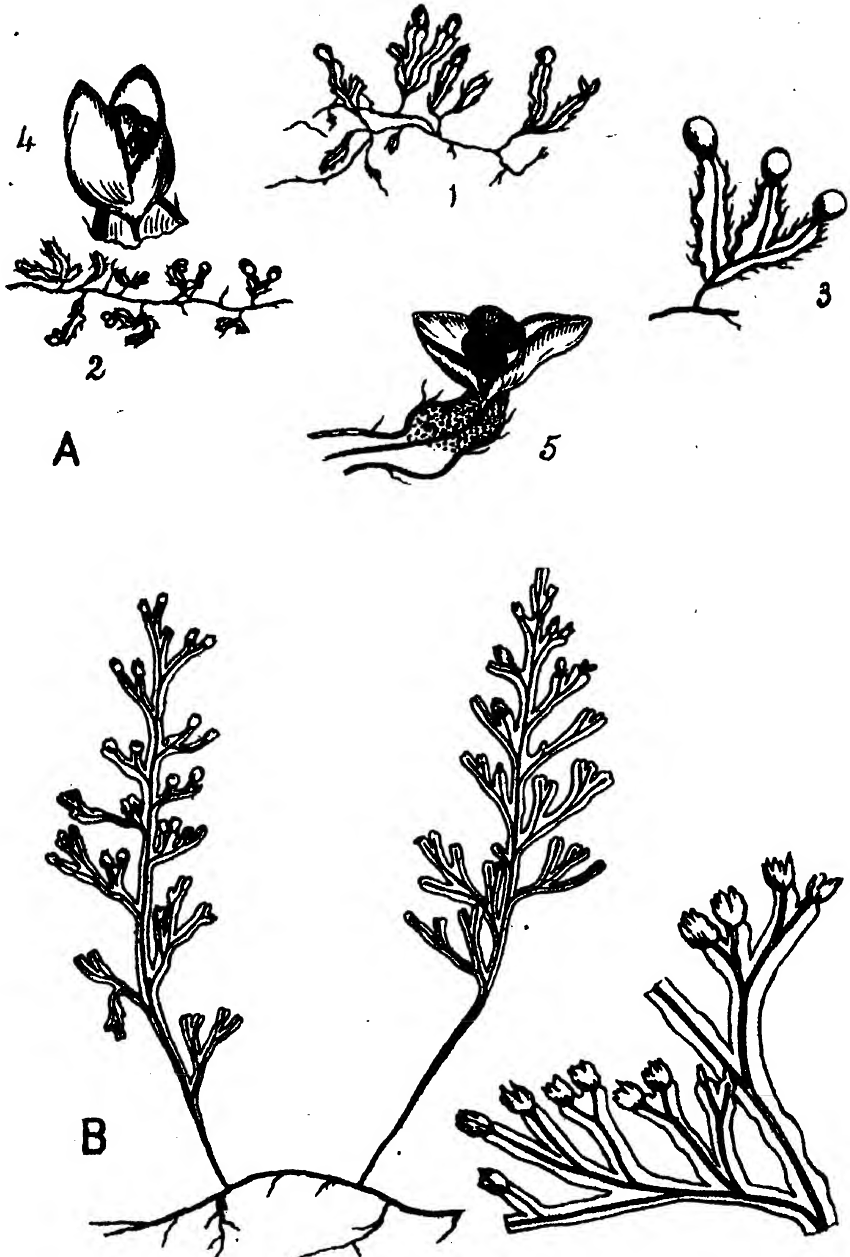
This interesting addition to our flora was discovered on mountains at the head of Lake Wakatipu by Mrs. Mason, of Queenstown, to whose kindness I am indebted for specimens.

In habit our plant closely resembles *Trichomanes humile*, but the frond is broader at the base, the pinnæ more divided and spreading. It has affinities with *H. javanicum*, Spreng., and might possibly be overlooked as a stunted condition of that species but for its different habit. In addition to the larger and more highly divided frond, *H. javanicum* is distinguished from the present species by its rounded involucres and crisped wings and segments. *H. montanum* is distinguished from other New Zealand species by its narrow involucres with deeply toothed or jagged tips; it is of membranous texture and of a dull green hue.

In old specimens the segments are slightly constricted immediately below the base of the involucre.

Plate XXI.—B.

1. *Hymenophyllum montanum*, natural size.
2. Fertile pinnæ, magnified.



A. *HYMENOPHYLLUM ARMSTRONGII, Kirk.*

B. " *MONTANUM, n.s.*

ART. LVII.—*On* Hymenophyllum villosum, *Colenso.* By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 12th January,* 1878.]

THIS small species has long been a source of perplexity to fern collectors in this colony, by the majority of whom it has been mistaken for *Hymenophyllum ciliatum*, Swartz, a species of wide distribution, but only known in New Zealand from specimens collected in the Nelson district by Mr. Travers. *H. villosum* was originally discovered by Mr. Colenso in 1842, and described by him in the London Journal of Botany for 1844. Sir William J. Hooker, in "Species Filicum," referred it to *H. polyanthos*, *β. sanguinolentum*, a view which has been adopted by Sir Joseph D. Hooker in his "Flora Novæ-Zelandiæ" and "Handbook of the New Zealand Flora." It must, however, be regarded as a distinct species, having a wide subalpine and alpine range in New Zealand, although I am not aware of its occurrence elsewhere. I am glad to say that Mr. Baker, who has kindly compared my South Island specimens with those originally sent to Kew by Mr. Colenso, agrees with me as to its specific validity.

Hymenophyllum villosum.

Colenso in London Journal of Botany, vol. III., p. 35: Tasmanian Philosophical Journal, vol. II., p. 185.

Rhizome wiry, creeping. Stipes 1–2 inches long, narrowly winged or wingless, villous; frond 2–5 inches high, 1–2 inches broad, opaque, of a dull brownish-green; broadly ovate, or ovate-acuminate, tripinnate, villous; main rachis 1–3 inches long, narrowly winged, flexuose, villous; primary and secondary pinnæ deltoid; tertiary pinnæ twice or thrice divided into narrow linear forked segments. Sori terminal and axillary, free, orbicular, broader than the segments, 2-valved to the base; valves entire.

Hab. On rocks and trees in moist situations.

North Island: Ruatahuna—*W. Colenso*, 1842; summit of Tarawera (amongst moss), 4,000 feet—*T. K.*

South Island: Mountains of the Amuri, Nelson, 3,000–4,000 feet—*T. K.*; mountains above Broken River, Canterbury—*J. D. Enys!*; Upper Waimakariri and Arthur's Pass, 2,000–3,000 feet—*J. D. Enys* and *T. Kirk*: Ashburton—*T. H. Potts!*; the Routeburn and mountains above Lake Harris, Otago, 4,000 feet—*T. K.*

I have seen specimens from other parts of the South Island, but am ignorant of the precise localities in which they were collected. In all probability our plant is common throughout the colony at elevations above the highest limit of *H. polyanthos*, although but rarely occurring below.

The fronds of our plant are more highly divided than those of any other New Zealand species, and present, especially in small specimens, a peculiar

crowded appearance, caused by the overlapping of the pinnæ and segments. In small specimens the rachis and stipes are often winged nearly to the base; in the circinate state the fronds are densely clothed with ferruginous hairs; fronds are occasionally found with the lowest pinnæ undeveloped, as in *H. multifidum*. In its most luxuriant state *H. villosum* is quadripinnate, and in habit resembles the European *Trichomanes radicans*, Swartz, when growing in moist situations.

The affinities of our plant are with *H. polyanthos*, Swartz, and *H. demissum*, Swartz; from the former it differs in possessing longer and narrower segments and terminal orbicular sori; it may readily be distinguished from the latter by its small size and orbicular involucres, which have entire lips and are broader than the segments. In colour, texture, and the presence of hairs, it approaches *H. scabrum*, A. Rich., and in the position of the sori and their relative breadth as compared with the segments, it resembles *H. javanicum*, Spreng. From all the species here named, except *H. scabrum*, it is distinguished by its villous character.

Mr. Colenso describes the involucres as "ovate, * * pedicelled." I find these characters only in small and imperfectly fruited specimens; the apparent pedicels are simply contracted segments.

Art. LVIII.—*On* Lindsaya viridis, *Colenso*. By T. Kirk, F.L.S.

[*Read before the Otago Institute, 17th January, 1878.*]

This elegant fern was originally discovered at Mangarewa, in 1842, by Mr. Colenso, and described by him as *Lindsæa viridis* three years later, but owing to its having been referred to *L. trichomanoides* by Sir W. J. Hooker, in 1846, it is only after the lapse of thirty years that its specific validity has become recognized in Europe, although it is separated from its nearest allies by strongly marked differential characters. Without doubt this long neglect is in part owing to the rarity of the plant itself, for, although occurring in both islands, it is remarkably local, and for the most part its habitats are far apart. The few New Zealand botanists who have collected it are unanimous in their opinion as to its specific validity.

In the first edition of "Synopsis Filicum," published in 1868, Mr. Baker separated our plant from *L. trichomanoides* and united it with the Australian *L. microphylla*, Swartz, but two years ago was led to reconsider the question through Wanganui specimens transmitted to Kew by Mr. H. C. Field, under the idea that it was still considered a form of *L. trichomanoides*. Mr. Baker adopted the view held by botanists in the colony and published our plant as

a distinct species, under its original name, evidently without being aware that it was described by Mr. Colenso thirty years ago. I have, therefore, the greater pleasure in appending a description of the species, for the use of local botanists, that it affords me the opportunity of presenting the claims of its discoverer in their proper light.

Lindsaya viridis.

Lindsæa viridis.

Colenso, Filices Novæ Novæ Zelandiæ, p. 14 (1845); Tasmanian Journal, II., p. 174.

Lindsaya viridis, Colenso.

J. G. Baker in Journal of Botany (new series), IV., p. 108.

Lindsæa trichomanoides, Dryander (in part).

Hook., Species Filicum, I., p. 218; Hook. fil., Fl. Nov. Zel., II., p. 20: Handbook N.Z. Flora, p. 359.

Lindsaya microphylla, Swartz (in part).

J. G. Baker in Synopsis Filicum, edits. 1 and 2, p. 110.

Fronds tufted, 6–12 inches long, 1 inch wide, membranous, bright green, stipes 1–3 inches, triquetrous, channelled, shining, naked except a tuft of linear brown scales at the base, frond lanceolate, or lanceolate acuminate, bi- or tri-pinnate, rachis flexuous; pinnæ ascending, alternate, 1–1½ inch long, obliquely lanceolate, or rhomboid lanceolate; pinnules simple or deeply lobed, or cut to the base into 2–4 linear cuneate segments, margins truncate, erose, about a line deep and twice as broad; veins indistinct, simple or rarely branched.

Hab. On wet rocks.

North Island: Port Fitzroy, Great Barrier Island, plentiful about waterfalls—*Mr. Springall!* Manukau Harbour, dripping rocks at the Huia Creek, and waterfalls between the Huia and the sea—*T.K.* Te Whau—*T.K.* Mangarewa—*Mr. Colenso.* Wanganui River—*H. C. Field!*

South Island: Nelson, under high rocks in a deep ravine, Massacre Bay—*Lyall.* Canterbury—*Sinclair* and *Haast.* Hokitika—*W. H. Tipler!* West coast of Otago—*J. Buchanan.*

The Nelson and Canterbury habitats are stated by Mr. Baker in the "Journal of Botany," on the authority of specimens in the Kew herbarium. I have reason to believe that the supposed Canterbury specimens were collected by Dr. Sinclair at the Huia, and accidentally misplaced, so that the habitat in question requires confirmation.

Our plant attains its greatest luxuriance on vertical dripping rocks where the fronds grow at a right angle to the face of the rock, and are narrower and more rigid than when growing on a horizontal surface. In the latter situation the fronds are radiating and drooping at the tips, with the pinnæ somewhat spreading, so that the frond is relatively wider. The finest

specimens I have seen were growing on vertical dripping rocks at the Huia Creek; some of the fronds are fully sixteen inches long, but not quite so wide as shorter fronds of more lax habit grown on a horizontal surface at Port Fitzroy. In some places where it has the advantage of a continuous supply of moisture, it is exposed to the glare of the sun for a portion of the day, but with little appreciable effect on its delicate texture.

In an immature state this species may easily be mistaken for a *Davallia* from its narrow sori, which are never wider than twice their depth, and do not extend to the lateral margins of the segments. Mr. Baker points out that "the anterior valve is a continuation of the lamina, while the posterior valve is membranous, both alike incised."

The affinities of *Lindsaya viridis* are with *L. trichomanoides*, Dryand., and *L. microphylla*, Swartz. The former differs from our plant in its creeping, chaffy rhizomes, broadly ovate coriaceous fronds, spreading, usually opposite pinnæ, and fan-shaped segments with branched veins; it is confined to forests, and extends from the North Cape to Dusky Bay. *L. microphylla* is confined to temperate Australia, and is distinguished from *L. viridis* by its larger size, more distant pinnæ, and the sori forming a continuous marginal line, the width being more than twice the depth. *L. viridis* is endemic in New Zealand. *L. trichomanoides* is found also in Tasmania, New South Wales, and Fiji.

Art. LIX.—*On* Nephrodium decompositum, *Br.*, *and* N. glabellum, *A. Cunn.* By T. Kirk, F.L.S.

[Read before the Wellington Philosophical Society, 1st December, 1877.]

In the "Hand-book of the New Zealand Flora" these plants are considered identical; in the "Flora Novæ-Zelandiæ," the second is described as a variety of the first. They are, however, so easily recognized at sight that a singular unanimity of opinion prevails amongst New Zealand botanists in favour of their being considered specifically distinct. I purpose, therefore, briefly to examine the differential characteristics of the two plants.

In *N. decompositum* the rhizome is elongated, slender, more or less clothed with chaffy scales and the distant bases of old fronds; it is frequently branched and extensively creeping so that the plant often forms patches several yards in diameter. Fronds erect, solitary, distant, never tufted or

springing from the apex of the rhizome, usually from 12–24 inches in height. Stipes from half to two-thirds the length of the entire frond, clothed with scattered chaffy scales and fine pubescence, angular, channelled; the frond is from 7–10 inches wide with the apex elongated and the lowest pair of secondary pinnæ much developed, so that its general outline is pentangular acuminate; bi- or tri-pinnate, membranous, villous or pubescent; rachis slender; lowest pair of pinnæ much the largest, 5–7 inches long, 3–4 inches wide, obliquely deltoid; upper pinnules lanceolate, pinnate, or deeply pinnatifid, ultimate segments ovate or rhomboid ovate with acutely toothed lobes. Sori attached nearer the margin of the segment than the midrib.

In *N. glabellum* the rhizome is short, stout, densely clothed with the wiry bases of old fronds, unbranched. Fronds from 4–6 in number, tufted, springing from the apex of the rhizome and usually of less size than those of *N. decompositum*. Stipes always more than half the length of the entire frond, scaly at the base, naked above, reddish, channelled, from 7–10 inches long, 6–9 inches wide, deltoid, acuminate, twice or thrice pinnate, slightly coriaceous, glossy; lowest pair of pinnæ 4–5 inches long, 2–3 inches wide, less obliquely deltoid than in *N. decompositum*, with the basal pinnules much less developed, and rachis more prominently winged; segments pinnate or deeply pinnatifid, with the basal lobes overlapping so as to form a connected line on each side of the rachis of the lowest pinnæ; lobes obtusely toothed, veins prominent. Sori equi-distant between the margin of the segment and the midrib.

While freely admitting the close resemblance in the cutting and in the general outline of these plants, the essential differences indicated appear to me sufficient to warrant these plants being considered specifically distinct, but it is necessary to offer a few remarks on their nomenclature, which is somewhat confused, the specific name "*glabellum*" having been applied to both.

The earliest description of either is that of *N. decompositum*, by R. Brown, in his "Prodromus Floræ Novæ Hollandiæ," p. 149 (1810). The next is that of *N. glabellum*, by Allan Cunningham, in Hooker's "Companion to the Botanical Magazine," II., p. 367, and which is clearly the plant to which the name is now applied.

In the "Flora Novæ-Zelandiæ," II., p. 39, under *N. decompositum*, Brown's plant is described and figured as var. *a. glabellum*, *N. glabellum*, Cunn. Although corrected by Sir W. J. Hooker, in "Species Filicum," IV., p. 146, owing to the wide circulation of "Flora Novæ-Zelandiæ" the error has become generally circulated, and caused much confusion, especially in this colony.

The following is the synonomy of each so far as known to me:—

Nephrodium decompositum.

Hooker fil., Fl. Tasmaniæ, II., p. 149; Brown, Prodromus Nov. Holl., p. 149; Baker, Synopsis Filicum, p. 281; Hook. f., Handbook N.Z. Fl., p. 378.

N. decompositum, a. glabellum, Hook. fil,. Fl. Nov. Zel., II., p. 39, t. 79 (not of Cunningham).

N. decompositum, a. macrophyllum, Hook., Sp. Filicum, IV., p. 146.

N. pentangularum, Colenso, Filices Novæ Novæ-Zelandiæ, p. 9 (1845).

Aspidium decompositum, Spreng., Syst. Veg., IV., p. 109; Mueller, Fragmenta Phytographiæ Australiæ, V., p. 136.

Aspidium microsorum, Endl., Flora Norfolk Island, p. 9.

A. shepherdi, Kunze, Linnæa, XXIII., p. 259.

A. acuminata, Lowe, Filices, p.—. t. 11.

Hab. New Zealand, common on the banks of rivers.

Australia, Tasmania, Norfolk Island.

Nephrodium glabellum.

A. Cunningham, Comp. Bot. Mag., II., p. 367; Metten. Aspid., p. 69.

Nephrodium decompositum, β. pubescens, Hook. f., Fl. Nov. Zel., II., p. 39.

N. decompositum, β. microphyllum, Hook., Sp. Filicum, IV., 146.

Lastrea davalloides, Brack., Filices U.S. Exploring Expedition, p. 202.

Hab. New Zealand, common in forests.

Australia, Tahiti, Fiji Islands.

Art. LX.—*On the Botany of the Bluff Hill.* By T. Kirk, F.L.S.

[*Read before the Otago Institute, 17th January, 1878.*]

The isolated hill which guards the entrance to the Bluff Harbour has long been supposed to exhibit features of special interest to the botanist, but no one has even imagined that it possessed a rich or varied flora. It was therefore with no little surprise that I found it vying with the North Cape in botanical riches, which, although of a less showy character, were not less attractive.

My examination of the locality was restricted to some portion of the forest beyond the pilot station, and to parts of the hill within reach during a rambling ascent from the town to the flagstaff.

The Bluff Hill is a little under 900 feet in height, and rather less than two miles in diameter at its greatest width; its base is washed by the sea, except on the side which connects it with the promontory of which it forms the termination. It consists chiefly of syenite and clay-slates, the latter in many cases nearly vertical. The hollows and sides of the watercourses

on the exposed portion are occupied by patches of swamp, but much of the surface vegetation has been destroyed by repeated burnings, so that at first sight it appears about as unfavourable a locality for rare plants as could well be imagined.

Its southern face is covered with forest, bearing a general resemblance to the Seaward forest; but differing in the reduced proportion of matai and iron-wood, and in the diminished luxuriance caused by exposure, elevation, and soil.

The chief timber trees are the kamai (*Weinmannia racemosa*), rimu (*Dacrydium cupressinum*), miro (*Podocarpus ferruginea*), and iron-wood (*Metrosideros lucida*); of these the kamai is the most abundant; many specimens rival in size and luxuriance the finest to be seen in the Seaward forest, although in most cases they are of less dimensions.

A dense growth of *Olearia nitida*, *Veronica elliptica*, *Aristotelia fruticosa* and other shrubs is found at the sea margin, and gives shelter to a number of ferns and herbaceous plants, the most noteworthy of the former being *Lomaria dura*, which, like its near ally *L. banksii*, never grows far out of reach of the sea spray. On the outskirts of the forest the trees are much shorn and stunted by the wind: the largest trees occur in the hollows and sheltered places, still serviceable timber is found near the summit. Although the yield of timber per acre is very small when compared with the best parts of the sheltered forest on the downs, it would be more durable in quality.

A few cattle have access to the forest, but no great amount of injury has resulted from this cause at present. In all directions young trees were plentiful, from seedlings upwards, showing that a continuous process of renewal is taking place.

The underwood and the herbaceous vegetation exhibited the greatest luxuriance of growth; some of the leaves of the tataramoa (*Rubus australis*) were the largest I ever saw. *Chiloglottis cornuta*, an orchidaceous plant growing in several localities from Omaha to the Chatham and Auckland Islands, but remarkably local, exhibited a stout, robust habit quite new to me. *Juncus nova-zelandica* attains an extraordinary size, and exhibits a marked contrast to the ordinary specimens found on the open side of the hill. In sheltered places near the summit *Cyathodes acerosa* assumes a free growing luxuriant habit not frequent even in the north, and, with its profuse display of white and red fruit, presents a most attractive appearance. This remarkably luxuriant growth of the shrubby and herbaceous vegetation was evident wherever shelter could be obtained from the direct action of the wind, and must be chiefly attributed to the great amount of moisture constantly present in the atmosphere, and which is prevented from becoming injurious by the frequent high winds.

Ascending the hill direct from the town, but diverging widely from the beaten track, the first plant collected of special interest was *Juncus lamprocarpus*, a recent addition to our flora. Stunted specimens of *Carpha alpina* were observed at less than twenty yards above the sea-level. *Gratiola nana* occurred in several spots, and on swampy ground *Drosera spathulata* was abundant. On a patch of peaty soil at no great elevation the rarest of the New Zealand sun-dews, *Drosera pygmæa*, occurred sparingly. It is a minute plant, not more than half an inch across, and from its grey tinge may easily be passed over. It was originally discovered by Mr. Colenso at Cape Maria van Diemen nearly forty years ago, and hitherto has not been observed elsewhere in the colony, although in Tasmania and Australia it has a wide distribution in littoral situations. There can be no doubt that its minute size and insignificant appearance have caused it to be overlooked in New Zealand.

The alpine *Carex cataractæ* was observed at a low elevation associated with the white-flowered *Mimulus radicans* and small plants of *Schœnus axillaris*, not previously recorded from the South Island. *Hydrocotyle muscosa* and *Eleocharis gracillima* were found in swampy situations. *Thelymitra uniflora* waved its graceful purple flowers on peaty ground below the summit, sheltering its near ally *Caladenia bifolia*. *Callixene parviflora* with its attractive waxy flowers and fruit covered the surface, in some places intermixed with *Herpolirion novæ-zelandiæ*. A new species of *Haloragis*, recently described as *H. uniflora*, often formed a dense sward; the plant is readily distinguished from its allies by the solitary terminal flower. Marshy spots were occupied by *Oreobolus pumilio* with the characteristic mountain plant *Cyathodes empetrifolia* attaining great luxuriance on the drier ground.

Isolepis cartilaginea, a species of remarkably local distribution, occurred in one or two places, and a small species, doubtfully referred to *I. fluitans* for the present, was found in plashy spots near the summit.

The limited time at my command only allowed me to examine the restricted portions of the Bluff Hill already mentioned, but the results of my investigation warrant the inference that one-fourth of the entire phænogamic and fern flora of the colony may be collected here by a diligent investigator—an unusually high proportion to be found on such a small area and under many unfavourable conditions.

The adjacent Seaward forest is not nearly so rich in species as the Bluff Hill although its general growth is more luxuriant. This wealth of species in the latter locality must be attributed to the continuous supply of moisture present in an atmosphere frequently agitated by high winds and to the greater variety of soil and situation.

Only twenty-three species of naturalized plants were collected—a paucity which contrasts strongly with their abundance in the North Island. None of the species observed call for special remark.

The following are the most interesting of the indigenous species:—

Melicytus lanceolatus, Hook. f. Long supposed to be peculiar to the north, but is now found throughout the colony, although often local.

Drosera pygmæa, DC. A minute rosulate plant with numerous filiform one-flowered scapes, and a silvery cone in the centre, covering a hybernating bud. The cone is formed by the interlaced, laciniate, scarious stipules. The apparent distribution of this plant in New Zealand is most peculiar—a single habitat at the north-western extremity of the colony and another in the extreme south.

Haloragis uniflora, T. Kirk. On peaty ground below the summit.

Stylidium subulatum, Hook. f. Plentiful on peaty ground just below the summit: one or two plants were observed at less than twenty yards above sea-level.

Rumex neglectus, T. Kirk. Beyond the Pilot Station.

Caladenia bifolia, Hook. f. In the forest and on peaty ground near the summit; leaves varying greatly in size and shape.

Chiloglottis cornuta, Hook. f. Abundant in the forest and of large size.

Prasophyllum nudum, Hook. f. Open places near the summit.

Juncus lamprocarpus, Ehrh.

Isolepis cartilaginea, Br.

Lomaria dura, Moore.

Abundant in wooded rocky places by the sea.

Catalogue of Phænogamic Plants and Ferns observed on the Bluff Hill, 1st January, 1877.

NOTE.—Naturalized plants are marked with an asterisk.

RANUNCULACEÆ.
Clematis hexasepala, Hook. f.
Ranunculus hirtus, Banks and Sol.
rivularis, Banks and Sol.

MAGNOLIACEÆ.
Drimys colorata, Raoul.

CRUCIFERÆ.
Nasturtium palustre, DC.
Cardamine hirsuta, L.

VIOLARIEÆ.
Viola cunninghamii, Hook. f.
Melicytus ramiflorus, Forst.
lanceolatus, Hook. f.

PITTOSPOREÆ.
Stellaria parviflora, Banks and Sol.
* *media*, With.
Colobanthus billardieri, Fenzl.
* *Sagina procumbens*, L.

HYPERICINEÆ.

Hypericum japonicum, Thunb.

TILIACEÆ.

Aristotelia racemosa, Hook. f.

GERANIACEÆ.

Geranium dissectum, L., var. *caroliniannum*.
microphyllum, Hook. f.
sessiliflorum, Car.
molle, L.

CORIARIEÆ.

Coriaria ruscifolia, L.

LEGUMINOSÆ.

* *Ulex europæus*, L.
* *Trifolium repens*, L.
* *minus*, Sm.

ROSACEÆ.

Rubus australis, Forst.
Potentilla anserina, L.
Acæna sanguisorbæ, Vahl.

SAXIFRAGEÆ.

Carpodetus serratus, Forst.
Weinmannia racemosa, Forst.

CRASSULACEÆ.

Tillæa moschata, DC.

DROSERACEÆ.

Drosera pygmæa, DC.
spathulata, Labill.
binata, Labill.

HALORAGEÆ.

Haloragis alata, Jacq.
depressa, Hook. f.
uniflora, T. Kirk.
micrantha, Br.
Myriophyllum pedunculatum, Hook. f.
Gunnera monoica, Raoul.

MYRTACEÆ.

Leptospermum scoparium, Forst.
Metrosideros lucida, Menzies.
hypericifolia, A. Cunn.

ONAGRARIEÆ.

Fuchsia excorticata, L. fil.
colensoi, Hook. f.
Epilobium alsinoides, A. Cunn.
tetragonum, L.
Glossostigma elatinoides, A. Cunn.

UMBELLIFERÆ.

Hydrocotyle asiatica, L.
americana, L.
muscosa, Br.

UMBELLIFERÆ.—*continued.*

Hydrocotyde moschata, Forst.
microphylla, A. Cunn.
Crantzia lineata, Nuttall.
Apium filiforme, Hook.
Oreomyrrhis colensoi, Hook. f.

ARALIACEÆ.

Panax simplex, Forst.
edgerleyi, Hook. f.
crassifolium, Done. and Planch.

CORNEÆ.

Griselinia littoralis, Raoul.

RUBIACEÆ.

Coprosma rotundifolia, A. Cunn.
divaricata, A. Cunn.
tenuicaulis, Hook. f.
fœtidissima, Forst.
Nertera depressa, Banks and Sol.
Galium umbrosum, Forst.
Asperula perpusilla, Hook. f.

COMPOSITÆ.

Olearia nitida, Hook. f.
Celmisia longifolia, Cass.
Lagenophora forsteri, DC.
petiolata, Hook f.
* *Bellis perennis*, L.
,, ,, Mitchen, flowered variety.
* *Anthemis arvensis*, L.
* *nobilis*, L.
Cotula coronopifolia, L.
dioica, Hook. f.
Cassinia vauvilliersii, Hook. f.
Gnaphalium bellidioides, Hook. f.
trinerve, Forst.
filicaule, Hook. f.
luteo-album, L.
involucratum, Forst.
collinum, Labill.
Microseris forsteri, Hook. f.
* *Hypochæris radicata*, L.
Taraxacum dens-leonis, Desf. The indigenous and naturalized forms are both found.
Sonchus oleraceus, L.

STYLIDIEÆ.

Stylidium subulatum, Hook. f.

CAMPANULACEÆ.

Wahlenbergia gracilis, A. Rich.
Pratia angulata, Hook. f.
Selliera radicans, Car.

ERICEÆ.
Gaultheria rupestris, Br.
Cyathodes acerosa, Br.
empetrifolia, Hook. f.
Leucopogon fraseri, A. Cunn.
Dracophyllum urvilleanum, A. Rich.

MYRSINEÆ.
Myrsine urvillei, A. DC.

PRIMULACEÆ.
* *Anagallis arvensis*, L.
Samolus repens, Pers.

APOCYNEÆ.
Parsonsia albiflora, Raoul.

GENTIANEÆ.
Gentiana saxosa, Forst.

CONVOLVULACEÆ.
Convolvolus tuguriorum, Forst.
Dichondra repens, Forst.
β. *brevifolia*.

SCROPHULARINEÆ.
Mimulus radicans, Hook. f.
Gratiola nana, Bentham.
Veronica salicifolia, Hook. f.
elliptica, Forst.

LABIATÆ.
Mentha cunninghamii, Benth.

PLANTAGINEÆ.
* *Plantago major*, L.
* *lanceolata*, L.
* *raoulli*, Dec.

PARONYCHIEÆ.
Scleranthus biflorus, Hook. f.

POLYGONEÆ.
Polygonum aviculare, L.
Muhlenbeckia complexa, Meisn.
Rumex flexuosus, Forst.
neglectus, T. Kirk.
* *viridis*, Sibth.
* *acetosella*, L.

THYMELEÆ.
Pimelea prostrata, Vahl.

CONIFERÆ.
Podocarpus ferruginea, Don.
Dacrydium cupressinum, Sol.

ORCHIDEÆ.
Gastrodia cunninghamii, Hook. f.
Caladenia bifolia, Hook. f.
Pterostylis banksii, Br.
β. .
Chiloglottis cornuta, Hook. f.
longifolia, Forst.

ORCHIDEÆ.—*continued.*
Thelymitra uniflora, Hook. f.
Prasophyllum nudum, Hook. f.
pumilum, Hook. f. (?)
Specimens imperfect.

IRIDEÆ.
* *Iris germanica*, L.
Libertia ixioides, Spreng.

NAIADEÆ.
Triglochin triandrum, Mich.
Potamogeton "*natans*," L.

LILIACEÆ.
Rhipogonum scandens, Forst.
Callixene parviflora, Hook. f.
Dianella intermedia, Endl.
Astelia grandis, Hook. f.
Herpolirion novæ-zelandiæ, Hook. f.

JUNCEÆ.
Juncus australis, Hook. f.
communis, E. Meyer.
β. *hexasepalus*.
lamprocarpus, Ehrh.
var.
bufonius, L.
novæ-zelandiæ, Hook. f.
Luzula campestris, DC., var. *congesta*.

RESTIACEÆ.
Leptocarpus simplex, A. Rich.

CYPERACEÆ.
Schœnus axillaris, Hook. f.
Carpha alpina, Br.
Eleocharis acuta, Br., var. *platylepis*.
gracillima, Hook. f.
Isolepis nodosa, Br.
prolifer, Br.
riparia, Br.
cartilaginea, Br.
fluitans, Br. (?)
Specimens imperfect, and identification consequently uncertain.
Lepidosperma tetragona, Labill.
Oreobolus pumilio, Br.
Uncinia australis, Pers.
rupestris, Raoul.
banksii, Boott.
Carex virgata, Sol.
β. *secta*.
ternaria, Forst.
lucida, Boott.
cataractæ, Br.
breviculmis, Br.
trifida, Cavanilles.

GRAMINEÆ.
* *Anthoxanthum odoratum*, L.
Hierochloe redolens, Br.
Agrostis æmula, Br.
quadriseta, Br.
conspicua, Forst.
Dichelachne crinita, Hook. f.
Danthonia semi-annularis, Br.
* *Holcus mollis*, L.
* *Aira caryophyllea*, L.
Poa breviglumis, Hook. f.
* *annua*, L.
* *pratensis*, L.
australis, Br., var. *lævis*.
colensoi, Hook. f.
* *Lolium perenne*, L.

FILICES.
Gleichenia circinata, Swartz, β. *hecistophylla*.
Hemitelia smithii, Hook. f.
Dicksonia squarrosa, Swartz.
antarctica, Br., var. *fibrosa*.
Hymenophyllum tunbridgense, Sm.
rarum, Br.
dilatatum, Swartz.
polyanthos, Swartz, var. *sanguinolentum*.

FILICES.—*continued*.
Hymenophyllum demissum, Swartz.
scabrum, A. Rich.
flabellatum, Labill.
Hypolepis tenuifolia, Bernh.
Pteris aquilina L., var. *esculenta*.
scaberula, A. Rich.
incisa, Thunb.
Lomaria procera, Spreng.
fluviatilis, Spreng.
discolor, Willd.
alpina, Spreng.
dura, Moore.
banksii, Hook f.
Asplenium obtusatum, Forst., var. *lyallii*.
falcatum, Lam.
bulbiferum, Forst.
flaccidum, Forst.
Aspidium aculeatum, Swartz, var. *vestitum*.
capense, Willd.
Nephrodium hispidum, Hook.
Polypodium rugulosum, Labill.
billardieri, Br.

LYCOPODIACEÆ.
Tmesipteris forsteri, Endl.

ART. LXI.—*Contributions to the Botany of Otago*. By T. KIRK, F.L.S.

[*Read before the Otago Institute, 17th January, 1878.*]

WITH the exception of three or four species mentioned to indicate an extension of their range of distribution, the following plants have not been enumerated in any previous contribution to our knowledge of the flora of Otago.* Most of them were observed during hasty visits to portions of the district in the winter of 1874 and the summer of 1876–7, both under circumstances which prevented my paying more than cursory attention to purely botanical subjects. A few species are mentioned on the authority of the "Handbook of the New Zealand Flora," and others on the authority of

* For a Sketch of the Botany of Otago, by J. Buchanan, see Trans. N.Z. Inst., I., p. 22. On Plants collected near Invercargill, by J. S. Webb, V., p. 360. Notes on Otago Plants, by G. M. Thomson, IX., p. 538.

See also Contributions to New Zealand Botany, by W. Lauder Lindsay, M.D., etc.; London, 1868.

specimens communicated by Mr. D. Petrie and Mr. G. M. Thomson, to whom I have great pleasure in expressing my thanks.

The chief interest of the following list consists in the corrected views it affords of the relative proportion of *Glumiferæ*, especially of the cyperaceous section, to other phænogams in the south; the *Gramineæ* are increased one-fourth and the *Cyperaceæ* nearly doubled as compared with Mr. Buchanan's Catalogue, in which the latter form less than one-twentieth of the entire number of flowering plants, a striking contrast to the ordinary proportion in the North Island which is one-tenth. The present list shows that the actual proportion in Otago is one-thirteenth, and that the small disparity which really exists is chiefly due to the deficiency in *Cladium* and *Schœnus*, which, although abundant in the north, are represented in Otago by a single species of the former and two of the latter. On the other hand all the New Zealand *Carices* are found in Otago with the exception of *C. chlorantha*, Br., *C. colensoi*, Hook. f., and *C. stellulata*, Good.; the last two will certainly be found within the district, but the first is restricted to the North Island where it is very local.

I hope to consider the chief points of interest in the distribution of Otago plants in a future paper.

It is a subject for regret that we know so little of the flora of Stewart Island and the Snares, which exhibit features of great importance. Little as we know of both, the flora of Stewart Island shows a connection between the peculiar plants of the south-west coast of Otago on one side, and those of the Chatham Islands on the other—while that of the Snares shows a connection with the Auckland Islands and the Chathams, apparently more close than that with the nearest portion of the main land. I venture to suggest to the members of the Otago Institute the propriety of making arrangements for the systematic investigation of the flora and fauna of these little known portions of their district.

RANUNCULACEÆ.

Clematis hexasepala, DC. Bluff Harbour.

afoliata, Buch. Waitaki Valley—*J. Buchanan.*

Ranunculus hirtus—Banks and Sol.

β. supinus. Valley of the Dart.

ternatifolius, T. Kirk. *R. trilobatus*, "Trans. N.Z.I.," p. 547, not of Kit. Catlin River.

nanus, Hook. Otago—*J. Buchanan! D. Petrie!* Above Lake Harris—*T.K.*

CRUCIFERÆ.

Lepidium incisum, Banks and Sol. A doubtful plant, with numerous slender, prostrate leaflets, branched stems referred to this species for the present. First observed by Mr. Petrie. Cape Whybrow.

VIOLARIEÆ.

Melicytus micranthus, Hook. f. Near Dunedin.

TILACEÆ.

Aristotelia "erecta," Buch. Lake district; Wyndham. 800–1,200 feet—*J. Buchanan.* I have not seen specimens of this plant.

STACKHOUSIEÆ.

Stackhousia minima, Hook. f. Waipori—*D. Petrie!*

LEGUMINOSÆ.

Carmichælia munroi, Hook, f. Near Cromwell—*Captain J. Campbell-Walker;* Cardrona Valley—*T. K.* Fruiting specimens only.

pilosa, Col. Mr. Petrie has sent Otago specimens apparently belonging to this species, but without locality.

flagelliformis, Col. A remarkable plant, which may possibly prove to be a form of this species, was obtained in the Cardrona Valley. It was characterized by long flexuous branches, numerous trifoliolate leaves with deeply-notchéd leaflets, and large fruit fully ½ inch in length, with a long straight beak.

ROSACEÆ.

Acæna glabra, Buch. Valley of the Dart.

A. inermis, Hook. f. Lake Wakatipu; Valley of the Dart, etc.; Lake Hawea.

A. depressa, T. Kirk. Cardrona Valley; Lake Hawea.

DROSERACEÆ.

Drosera pygmæa, DC. Bluff Hill.

HALORAGEÆ.

Haloragis uniflora, T. Kirk. Bluff Hill. *H. tenuissima* of Mr. Thomson's list (not of T. Kirk) must be referred here.

Myriophyllum pedunculatum, Hook. f. Bluff Hill—*T. Kirk;* Stewart Island—*G. M. Thomson!*

ONAGRARIEÆ.

Fuchsia colensoi, Hook. f. Oamaru; Bluff Harbour.

UMBELLIFERÆ.

Pozoa haasti, Hook. f. Mountains above Lake Harris, 4,000 feet.
Oreomyrrhis colensoi, Hook. f. Bluff Harbour.
Ligusticum filifolium, Hook. f. Mountains above Lake Harris.
intermedium, Hook. f. Chasland's Mistake—*D. Petrie!*

CORNEÆ.

Griselinia lucida, Forster. Dusky Bay, Chalky Bay—*Handbook;* Catlin River—*Lindsay.*

LORANTHACEÆ.

Loranthus decussatus, T. Kirk. Valley of the Dart.

RUBIACEÆ.

Coprosma serrulata, Hook. f. Mountains above Lake Harris.
repens, Hook. f. Mountains above Lake Harris.

COMPOSITÆ.

Olearia angustifolia, Hook. f. Stewart Island—*Handbook N.Z. Flora.*
lyallii, Hook. f. Living plants apparently belonging to this fine species have been obtained from the Snares by Captain Johnson and presented to the Botanic Gardens, Wellington. They vary considerably in the size and shape of the leaves, and in the marginal toothing, some leaves having the doubly serrate margin of *O. colensoi*, while others on the same plant are almost crenate, or obscurely toothed.
Celmisia discolor, Hook. f. Mountains above Lake Harris.
verbascifolia, Hook. f. Horse Ranges—*J. C. Webb!*
spectabilis, Hook. f. Above Lake Harris; Cardrona Range.
bellidioides, Hook. f. Near Lake Harris.
glandulosa, Hook. f. With the above.
walkeri, T. Kirk. Mountains above Lake Harris.
Brachycome odorata, Hook. f. A doubtful plant, characterized by its flaccid membranous leaves, scapes leafy at the base, is referred to this species for the present. Cape Whybrow—*T. K.*; near Dunedin—*D. Petrie!* Stewart Island—*G. M. Thomson!*
pinnata, Hook. f. Stewart Island—*Handbook.*
Cotula minor, Hook. f. The Bluff and other places.
Raoulia munroi, Hook f. Near Dunedin—*Dr. Lindsay, J. Buchanan!*
petriensis, T. Kirk. Mount St. Bathans—*D. Petrie!*
Senecio robusta, J. Buch. Mount Eglinton—*J. Morton!* mountains above Lake Harris—*T. K.;* mountains near the Greenstone—*J. Buchanan.*

Stylidieæ.

Stylidium subulatum, Hook. f. The Bluff Hill—*T. K.*; Flagstaff Hill, Dunedin—*J. Buchanan.*

Campanulaceæ.

Pratia angulata, Hook. f., var. *arenaria*. Catlin River.

Ericeæ.

Archeria traversii, Hook. f., var. *australis*. Common on the west coast of Otago—*Handbook.*

Boragineæ.

Myosotidium nobile, Hook. On the Snares, abundant; leaves sometimes 2 feet in diameter—*H. Armstrong;* Cruise of the Amherst, 1868. See "Trans. N.Z. Inst.," II., p. 176.

Solaneæ.

Solanum nigrum, Linn. Lake Hawea.

Scrophularineæ.

Gratiola nana, Benth. The Bluff Hill—*T. K.;* McRae's Diggings—*D. Petrie!*

Glossostigma elatinoides, Benth. The Bluff Harbour.

Veronica pimeleoides, Hook. f. Waitaki—*J. Kidd.*

macrantha, Hook. f. Mountains above Lake Harris.

canescens, T. Kirk. Oamaru—*J. Buchanan!*

Euphrasia repens, Hook. f. Bluff Island—*Handbook.*

Plantagineæ.

Plantago spathulata, Hook. f. Near Invercargill—*J. S. Webb!*

brownii, Rapin. Mountains above Lake Harris. The Otago plant is nearly glabrous, and in several respects approaches the Auckland Island form, figured on table 43 "Flora Antarctica," I., more closely than specimens from any other locality.

Chenopodiaceæ.

Chenopodium detestans, Kirk. Cultivated land near the outlet of Lake Wanaka.

Atriplex patula, L. Abundant on disturbed silt; Cape Whybrow.

Salsola kali, L. Ida Valley—*D. Petrie!* The Otago plant is less robust than the Australian form naturalized on the banks of the Waitemata, and, from its occurrence in company with *Chenopodium pusillum* in this remarkable inland locality, must be considered indigenous. Both plants are usually littoral, but are found in inland localities marking the site of ancient sea margins or exhausted brine springs.

POLYGONEÆ.

Rumex neglectus, T. Kirk. West Coast of Otago—*J. Buchanan!* Bluff Harbour—*T.K.*

THYMELEÆ.

Pimelea virgata, Vahl. A remarkable form, white, with a dense covering of silky hairs on the leaves, is plentiful on the Cardrona range.

lyallii, Hook. f. Descends to the sea-level at Chasland's Mistake—*D. Petrie!*

SANTALACEÆ.

Exocarpus bidwillii, Hook. f. Bed of the Waitaki—*Handbook.*

CUPULIFERÆ.

Fagus cliffortioides, Hook. f. Valley of the Dart. The spray of this species more closely resembles that of the European beech, *F. sylvatica*, than the other New Zealand species.

CONIFERÆ.

Libocedrus bidwillii, Hook. f. Near Dunedin, etc. This is doubtless the *L. doniana* of Mr. Buchanan's Catalogue of Otago Plants.

Dacrydium bidwillii, Hook. f.

α.

β.

West Coast of Otago—*Dr. Hector!*

ORCHIDEÆ.

Chiloglottis cornuta, Hook. f. The Bluff Hill.

Prasophyllum pumilum, Hook. f. Several imperfect specimens collected on the Bluff Hill appear identical with this species.

nudum, Hook. f. Mountains above Lake Harris; the Bluff Hill, etc.

NAIADEÆ.

Potamogeton oblongus, Vir. Near Invercargill—*J. S. Webb.*

P. pectinatus, L. Waihola Lake.

LILIACEÆ.

Astelia grandis, Hook. f. This is in part the *A. nervosa* of Mr. Buchanan's Catalogue.

[*A. banksii*, A. Cunn. Plants in the Dunedin Botanic Garden are said to have been found on "cliffs, near Dunedin," but the alleged habitat is extremely improbable and requires examination.]

JUNCEÆ.

Juncus lamprocarpus, Ehr. Plentiful about Invercargill; Bluff.

β. Ditches near Kew railway station.

CYPERACEÆ.

Schœnus axillaris, Hook f. The Bluff Hill.

Eleocharis sphacelata, Br. Bluff Island—*Lyall*, "Handbook." This habitat requires confirmation; the nearest authenticated habitat is in the Taupo country—fully 600 miles distant.

acuta, Br., var. *platylepis*. *E. gracilis* of Mr. Buchanan's list, * and of Fl. N.Z., not of Brown.

gracillima, Hook. f. Bluff Harbour, etc.

Isolepis cartilaginea, Br. The Bluff Hill.

fluitans, R. Br. Imperfect specimens from the Bluff Hill appear to be identical with this species.

Gahnia setifolia, Hook. f. Lake Wakatipu, etc.

Lepidosperma tetragona, Labill. Bluff Harbour.

Uncinia sinclairii, Boott. Valley of the Dart.

australis, Pers. Lake Wakatipu, etc.

rupestris, Raoul. Bluff Harbour.

filiformis, Boott. Routeburn.

banksii, Boott. Bluff Harbour.

Carex pyrenaica, Wahl., var. Mountains of Otago—*J. Buchanan*.

acicularis, Boott. Wet rocks on the ascent to Lake Harris.

inversa, Br. Valley of the Dart.

debilis, M. S. Mountains above Lake Harris.

virgata, Sol., var. *secta*. Oamaru.

appressa, Br. Milford Sound—*Dr. Hector*.

subdola, Boott. Lake Wakatipu, etc.

breviculmis, Br. The Bluff Hill.

neesiana, Endl. Catlin River.

dissita, Soland. Catlin River.

GRAMINEÆ.

Microlæna stipoides, Br. In a single locality near Oamaru—perhaps a recent introduction. It is, however, certainly native to Westland.

avenacea, Hook. f. Lake Wakatipu.

Apera arundinacea, Hook. f. Water of Leith, etc.

Agrostis canina, L., var. *subulata*. Lake Wanaka, etc.

billardieri, Br. Cape Whybrow.

Arundo "fulvida," Buch. Mataura River—*J. Buchanan*.

Danthonia flavescens, Hook. f. Southland.

Glyceria stricta, Hook. f. Moeraki, and other places on the east coast; Dunedin, etc.

Poa imbecilla, Forst. Balclutha, etc.

Festuca littoralis, Br. Near Cape Whybrow.

Filices.

Alsophila colensoi, Hook. f. Hills about Dunedin; Lake Wakatipu; Catlin River; Seafield Bush. Trunk sometimes 7 feet high.

Hymenophyllum montanum, T. Kirk. Mountains above Lake Wakatipu—*Mrs. Mason!*

villosum, Col. Routeburne; mountains above Lake Harris.

Davallia fosteri, Carruth. Dusky Bay—*Forster.* "Synopsis Filicum," edit. 2. This species is only known from Forster's original specimen in the British Museum.

Lindsaya viridis, Col. West Coast—*J. Buchanan.*

Lomaria dura, Moore. West Coast Sounds—*J. D. Enys!* Catlin River—*D. Purdie* and *P. Thompson!* Bluff Hill—*T. Kirk.* In situations exposed to the spray of the sea.

Lycopodiaceæ.

Lycopodium laterale, Brown. Stewart Island—*Mrs. Pearson!*

Corrigenda.

Panax lessonii, DC. Said to occur on the west coast of Otago, but it is to be feared that some mistake has been made. The plant appears to be confined to the Auckland district.

Pimelea urvilleana, A. Rich. Mentioned in Mr. Buchanan's list, but I greatly fear that some other species has been mistaken for it.

Potamogeton heterophyllus, Schreber. Included in the lists of Mr. Buchanan and Dr. Lindsay, but must be expunged as it is not a New Zealand plant. Young states of the so-called "*P. natans*" which developes copious submerged leaves have been mistaken for it throughout the colony.

Dichelachne stipoides, Hook. f. Included in Mr. Buchanan's list, but the precise locality forgotten. It is a northern plant finding its southern boundary at the East Cape, and is, at best, of extremely improbable occurrence in any part of the South Island.

Lomaria pumila, Raoul. Mr. Buchanan informs me that he mistook a small form of *L. membranacea*, Colenso, for this species. It is, however, not unlikely to occur on the west coast.

The following species may be expected to occur in the district, and should be carefully sought for:—

Olearia forsteri, Hook. f.
Celmisia munroi, Hook. f.
Lobelia anceps, Thunb.
Dacrydium westlandicum, T. Kirk.
Cordyline banksii, Hook. f.
Astelia linearis, Hook. f.
Phormium colensoi, Hook. f.
Cladium glomeratum, Br.
junceum, Br.
Gahnia hectori, T. Kirk.
ebenocarpa, Hook. f.
rigida, T. Kirk.
Uncinia leptostachya, Raoul.
Carex colensoi, Boott.
stellulata, Good.
Spinifex hirsutus, Labill.
Zoysia pungens, Willd.
Bromus arenarius, Labill.

Naturalized Plants *

RANUNCULACEÆ.

Ranunculus bulbosus, L. Oamaru, etc.

PAPAVERACEÆ.

Eschscholtzia californica, Cham. Shingly shores of Lake Hawea.

FUMARIACEÆ.

Fumaria muralis, Sond. Dunedin, etc.

CRUCIFERÆ.

Barbarea præcox, Br. Dunedin; Invercargill; Moeraki.
Sisymbrium officinale, L.
Capsella bursa-pastoris, DC.
Senebiera coronopus, Poiret.
didyma, Persoon.
Lepidium ruderale, L. Common by roadsides, etc. This is probably the *L. campestre* of Mr. Thomson's list, a species only found in cultivated land.
smithii, Hook. Roadsides, Bendigo.

CARYOPHYLLEÆ.

Dianthus barbatus, L. On the sites of abandoned gardens.
Silene quinquevulnera, L. Not unfrequent; probably the *S. gallica* of Mr. Thomson's list.
Stellaria graminea, L. Otago—*D. Petrie!*
Arenaria serpyllifolia, L. Otago—*D. Petrie.*
Sagina procumbens, L. Near Invercargill; Bluff Harbour.
Polycarpon tetraphyllum, L. Oamaru.
Spergula arvensis, L.

* See Trans. N.Z. Inst., vol. VII., 370.

MALVACEÆ.

Malva rotundifolia, L.

Lavatera arborea, L. Oamaru.

GERANIACEÆ.

Erodium cicutarium, L.

LEGUMINOSÆ.

Medicago denticulata, Willd. Dunedin; Moeraki.

Melilotus officinalis, L.

Trifolium procumbens, L.

Vicia hirsuta, Koch. Oamaru, etc.

sativa, L.

angustifolia, Roth.

ROSACEÆ.

Acæna ovina, A. Cunn. Otago—*G. M. Thomson!*

UMBELLIFERÆ.

Fœniculum vulgare, Gærtn. Dunedin, etc.

COMPOSITÆ.

Madia sativa, DC. About three miles from Balclutha, by the Mataura-road. Our plant is the *M. viscosa*, Car.

Anthemis arvensis, L.

Matricaria inodora, L.

Senecio sylvaticus, L. Cardrona Valley; near Queenstown.

Lapsana communis, L.

Hypochæris radicata, L.

Helminthia echioides, Gærtn.

Thrincia hirta, L.

GENTIANEÆ.

Erythræa centaurium, Pers. Oamaru.

POLEMONIACEÆ.

Collomia grandiflora, Daug. Queenstown; Cardrona.

Navarretia squarrosa, Hook. and Arn. In profusion by the coach-road between Elbow and Kingstown; between Queenstown and Lake Hawea.

BORAGINEÆ.

Myosotis strigulosa, Reich. Otago—*D. M. Petrie!*

SOLANEÆ.

Lycium barbarum, L. Balclutha; Invercargill, etc.

SCROPHULARINEÆ.

Verbascum thapsus, L.
Mimulus luteus, L. Dunedin ; Invercargill, etc.
moschatus, Daug. Hills above Water of Leith, Dunedin ; between Elbow and Lowther, etc.
Veronica arvensis, L.
agrestis, L.
buxbaumii, Ten. Near Balclutha.
Bartsia viscosa, L. Otago—*G. M. Thomson !*

VERBENACEÆ.

Verbena officinalis, L. Balclutha ; Mataura, etc.

LABIATEÆ.

Stachys arvensis, L.
Marrubium vulgare, L.
Prunella vulgaris, L. Mr. Thomson informs me that this is the *Ajuga reptans* of his list of naturalized plants.

POLYGONEÆ.

Rumex viridis, Sibth.
obtusifolius, L.

CHENOPODIACEÆ.

Chenopodium album, L.
viride, L.
botrys, L. Otago—*D. Petrie !*
Atriplex angustifolia, Huds. Cardrona, etc.
erecta, Sm. Otago—*D. Petrie !*

HYDROCHARIDEÆ.

Anacharis canadensis, Planch. Professor Coughtrey informed me that he had seen a fragment of this plant floating in water near Cromwell.

IRIDEÆ.

Iris germanica, L. Bluff Harbour.

GRAMINEÆ.

Phalaris canariensis, L.
Agrostis alba, L., *β. stolonifera*.
Aira caryophyllea, L.
Briza minor, L.
Cynosurus cristatus, L. Palmerston.
Festuca sciuroides, Roth. Horse Ranges ; Palmerston, etc.

Bromus sterilis, L.
racemosus, Parl. Dunedin, etc.
unioloides, Humb.
Lolium temulentum, L.
Hordeum murinum, L. Dunedin; Invercargill etc.

ART. LXII.—*Notes on three dried Specimens of Matai* (Podocarpus spicata.
By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 4th August*, 1877.]

THESE specimens were handed to me for examination by Captain J. Campbell-Walker, F.R.G.S., who received them from A. P. Seymour, Esq., M.H.R.

1. *Pelorus Valley.*—"Large tree over 4 feet diameter; sapwood ¾ inch. Difference between heart and sap clearly marked. Cut down March 20th, gathered April 12th. No fruit on it. This timber is very hard, heavy, and durable in ground,—the best of its class. I would use it for posts without hesitation."

This specimen was taken from a mature pistillate tree and exhibits numerous young fruit. The durability of the timber is due to its maturity, as evidenced by the large size and small quantity of sap.

2. *Locality not stated.*—"Wood very pale red; 3 inches of sap; line between heart and sap not at all distinctly marked; tree 18 inches diameter; cut April 1st; fruit on it sparsely scattered. This wood is very inferior; prey to large white grubs; gathered April 12th, 1877."

Taken from a young (pistillate) tree as shown by the comparatively small diameter and large proportion of indeterminate sap-wood, amounting to one-third of the entire diameter, so that the inferiority of the timber is easily accounted for.

Matai timber of all ages is liable to the attacks of larvæ, more especially when cut during the growing season; young timber to a greater degree than old.

3. *Pelorus Valley.*—"Three feet diameter; cut about April 1st; timber red, not very dark; sap 2½ inches thick; difference between sap and heart not well marked. This in my opinion is inferior. I would not use it for posts. Gathered April 12th. No fruit on tree."

The specimen was taken from a staminate tree, the timber of which, judging from the large amount of indeterminate sap-wood, was not well matured. In respect of durability the timber of this tree would prove intermediate between Nos. 1 and 2, but nearer the first.

Of course the opinions here given are based merely upon the foliage specimens taken in connection with the facts stated, and therefore might possibly be modified on an examination of the timber.

As a general rule small matai, say under 2 feet in diameter, must not be expected to prove of great durability, except perhaps when grown in rocky soils.

The relative durability of timber produced by different trees of the same kind, depends upon two primary causes—age, which gives maturity, and the conditions of growth so far as they conduce to lignification or otherwise.

It is a common idea amongst bushmen, that in matai, as in other New Zealand pines which produce the staminate and pistillate inflorescence upon separate trees, one form alone affords valuable timber, but unhappily they never agree as to which form produces the durable timber and which the worthless. As a matter of fact there is no evidence to show that either form is more valuable than the other, nor at present is there evidence to warrant the conclusion that any variety of matai affords more valuable timber than another: all the differences to which attention has yet been drawn may be shown to arise from the degree of maturity, conditions of growth, time of falling, seasoning, or some other cause capable of easy determination when the facts of the case are clearly ascertained.

Art. LXIII.—*Notice of the Discovery of* Monoclea forsteri, *Hook., in New Zealand.* By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 2nd February,* 1878.]

In "Flora Novæ-Zelandiæ" and "The Handbook of the New Zealand Flora," a plant of general distribution in this country is doubtfully described, in the absence of fruit, as *Dumortiera hirsuta*, Nees, the specimens apparently differing from that plant only in their larger size. Fruiting specimens recently obtained near Wellington show that it is the long-lost *Monoclea forsteri*, Hook.* (*Anthoceros univalvis*, G.E. Forst., MS.), all our knowledge of which was obtained from Forster's original specimens, and we were even destitute of exact information as to the locality in which it was collected.

Monoclea is a monotypic genus, and with *Calobryum* forms a section of *Hepaticæ* characterized by the solitary unilocular sporangium destitute of a columella, and having the elaters carried away with the spores.

* Musci Exotici, II., p. 174.

The thick, fleshy, irregularly-lobed and imbricated fronds of this common plant are so well known to every New Zealand botanist as to need no description. Fructification springing from cavities in the substance of the frond, tumid on the under surface, and opening by slits on the upper surface near the margin. Peduncles 1–3 in each cavity, 1–1½ inch long, succulent, white or yellowish, the base of each surrounded by a delicate, stipitate, tubular perianth ⅓–½ inch long, with a two-lobed mouth, the lobes jagged or rarely lacerate, not extending beyond the cavity. Peduncle consisting of two separate tubes closely fitting one within the other. Capsule oblong-cylindrical, coriaceous, faintly striated, sub-erect or inclined, dehiscing longitudinally, at length expanding into an oblong flattened valve coarsely striated within. Columella 0. Elaters and spores forming a densely matted dark-brown mass; elaters vermiform, with intersecting spiral bands; spores globose, minutely punctate.

The capsule is at first erect, but becomes inclined or even horizontal in dehiscence.

Our plant is frequently found growing in situations where it must be submerged for the greater part of the year; in places of this kind its fronds are perfectly flat and less coriaceous than in the usual state.

The fruiting condition appears to be remarkably local; my specimens were obtained from the head of a gully running into the Kaiwarawara. Mr. Buchanan has collected fruiting specimens at Wainuiomata; these are the only instances of its being found in fruit, since its discovery, most probably in the South Island, by Forster more than a century ago. It appears to fruit only during the spring months, October and November.

Art. LXIV.—*Descriptions of New Plants.* By T. Kirk, F.L.S.

[Read before the Wellington Philosophical Society, 2nd February, 1878.]

Umbelliferæ.

Pozoa pallida.

Glabrous, rhizome stout creeping, with crowded rosulate leaves at the apex and giving off scions. Leaves ½–¾ inch in diameter, 3-foliolate, leaflets sessile, cuneate or obovate-cuneate, 3–6-lobed at the tips, coriaceous, shining, pale green; petioles 1–3 inches long, stipules lacerate. Peduncles shorter than the leaves bearing a single terminal umbel, or with two or more umbels each successively given off from the one next below it; umbels with a petioled tripartite or lobed leaf at the base, 4–8-flowered;

flowers on slender pedicels ¼ inch long; involucres of about six simple membranous obtuse leaves. Fruit, pale, $\frac{1}{10}$ inch long, carpels not rounded at the back.

South Island: Nelson—Roto Iti; Amuri; Lake Guyon. Canterbury—Pukunui Creek.—Altitude, 2,000–8,000 feet.

Specimens without locality or collector's name are in the herbarium of the Colonial Museum.

This species has been confused by collectors with *P. trifoliolata*, of which Professor Oliver considers it a variety,—an opinion with which I cannot agree, its closest affinity being with *P. roughii* and *P. hydrocotyloides*. It is easily recognized in all stages by its pale green shining foliage, and never forms the densely-matted patches so characteristic of *P. hydrocotyloides*, from which it is further distinguished by its less coriaceous leaves, proliferous umbels, and pedicellate flowers. It is distinguished from *P. roughii* by the ternate leaflets, few flowered umbels, fruit shorter than the pedicels, and carpels not rounded at the back.

A single specimen in my possession has the peduncles branched with a single pedunculate umbel in the fork of each.

Rubiaceæ.

Coprosma arborea.

A tree 20–25 feet high; trunk 8–12 inches in diameter; wood yellow; branches ascending; leaves ovate-spathulate, coriaceous, reddish below, gradually narrowed into a winged petiole shorter than the blade, veins distinct. Male flowers densely capitate, sessile, axillary or terminal; calyx narrow, deeply 4–5-cleft, minutely ciliated; corolla bell-shaped, 4–5-cleft; lobes broad, obtuse. Female flowers in 4–5-flowered fascicles; calyx 4–5-lobed, lobes obtuse, minutely ciliated; corolla 4–5-partite nearly to the base; lobes ligulate, spreading; styles slender, short. Fruit crowded; globoso-ovoid, with obscure traces of the calyx limb at the apex, white, translucent.

North Island.—From Mongonui southwards to the head of the Hauraki Gulf. Abundant on Waiheke Island.

In the "Handbook of the N.Z. Flora" this species is confused with *C. spathulata* * to which it is closely allied, and from which it is distinguished

* I append an amended description of *C. spathulata*, A. Cunn. A sparingly-branched shrub 2–6 feet high; branches spreading or straggling; leaves distant, orbicular-spathulate, emarginate or obcordate, abruptly narrowed into the winged petiole, blade longer or shorter than the petiole, coriaceous, veins obscure. Male flowers in 2–3-flowered fascicles; calyx 4–5-lobed; corolla funnel-shaped, 4–5-partite divided for about half its length; lobes narrow. Female—calyx bell-shaped, 4–5-cleft; corolla 4–5-partite divided for less than half its length; segments narrow; style ½–⅔ inch long. Fruit ovoid, solitary, shortly peduncled, black, shining, crowned by the limb of the calyx.

by its arboreal habit, numerous ascending branches which are puberulous at the tips, the blade of the leaf always longer than the petiole, and never orbicular or obcordate; the densely aggregated flowers, never solitary; the bell-shaped deeply-divided corolla, shorter style, and crowded fruit.

The fruit when ripe is white and translucent, but soon becomes discoloured from decay. In the fruiting state this plant has some resemblance to *Myrsine australis*. It is much the largest species of the genus.

CYPERACEÆ.

Schœnus vacillans.

Culms simple, 9–18 inches long, flaccid, tufted, leafy, compressed; Leaves alternate, ascending, 2–3 inches long, $\frac{1}{25}$ inch broad, linear acute. Spikelets 1–4 axillary, on scabrid pedicels $\frac{1}{4}$–$\frac{1}{3}$ inch long, dark brown; 1–2-flowered; glumes 4–6 narrow lanceolate, keel scabrid; stamens 3, bristles 3. Nuts small, whitish, slightly trigonous, not polished; stigmas 2 or 3.

North Island.—Deep gullies at the source of the Matai River, Mount Wynyard.

This species is closely allied to *S. axillaris*, Br., but is easily recognized by its large size, longer flaccid leaves, clustered lanceolate spikelets and narrow glumes. It has not been observed elsewhere.

IV.—CHEMISTRY.

ART. LXV.—*On certain of the Mineral Waters of New Zealand.* By W. SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 12th January, 1878.*]

AT the instance of Dr. Hector I take up the subject of this paper, but all I think necessary to do at present in this matter is to collate from our several museum and laboratory reports statements of all the analytical results which I have obtained upon these waters, and to compare them with those of the celebrated European waters which ours resemble, stating at the same time their therapeutic properties, either as deduced from their composition, or such as to my knowledge have actually been discovered by direct observation.

The arrangement of these waters here will necessarily be a geographical one, for I find that to present them in anything like a chemical order, that is, classified according to their composition, would entail upon me a far greater expenditure of labour and time than I can well spare, as several compendious tables would in such case have to be re-cast,—in fact, completely broken up, owing to their arrangement being geographical, dominantly so at least. The task of presenting our mineral waters in chemical order I therefore leave for some future time, when the whole or the greater number of them shall have been analyzed.

There is this to be said in favour of the geographical arrangement I propose, viz., that it will enable anyone to gather at a glance the nature of all the waters of any particular district which have been reported on by the Geological Survey Department.

It will be observed that several of the analytical results I shall describe are very meagre, but I have decided to enter all that has been accomplished in the Colonial Laboratory upon these mineral waters, as a little information even regarding any water may be valuable, and suffice for one's wants until opportunities occur for making it fuller.

The following is a list of the localities whence the mineral waters described in this paper were obtained :—

	Lab. No.
1. Onetapu Desert, Auckland	151
2. Mahurangi, Auckland	156
3. Bay of Islands, Auckland	520

	Lab. No.
4. Puriri, Auckland	1404
5*a* and *b*. Waiwera, Auckland	1822, 1820
6. Aorangi, Auckland	1660
7. Rangitaika River, Bay of Plenty	187
8. White Island	282
9. Waimangeao, Bay of Plenty	1524
10. Rotorua, Auckland	1859 1/16,
11 and 11*a*. Taupo, Auckland	1406 1/12, 1500
12. Spring near lake on west side of Waikato River ...	252
13. Wallingford, Wellington	56
14. Pahua, Wellington	1211, 1907
15. Northern boundary of Wellington	1567
16. Akitio, Wellington	1758
17. Hanmer Plains, Nelson	500
18. Lake Sumner, Canterbury	1495
19. Gibson Station, Southland	1668

1. *Aluminous Water.*

The first specimen is from Wangaehu River, Onetapu Desert, in the Auckland provincial district, and was contributed by Mr. Mair on 18th January, 1868. It is persistently turbid, and has a very sour taste. The quantity of fixed matters present in one gallon of it are 456 grains, and their composition is mainly that of common alum. A large quantity of magnesium and ferrous chloride is also present.

2. *Mahurangi Water.*

From the springs near Mahurangi, Auckland provincial district, three samples were collected by Mr. Justice Gillies in January, 1868 :—

a. Cold spring, contains 74·0 grains of solid matter per gallon.
b. Hot spring, „ 140·4 „ „ „ „ „
c. Hottest spring, „ 141·6 „ „ „ „ „

The solid residues of *a* and *b* when analyzed proved to consist mainly of sodic and magnesium chlorides. None, however, of these samples were fully analyzed for want of material.

Mr. Justice Gillies has stated that the coolest of the springs had a temperature of 110° Fahr. at the time he obtained these samples; and that he "believed that many of our Auckland residents had derived much good from bathing in these springs *for the purpose of curing rheumatism*."*

3. *Acidulous Water.*

An acidulous mineral water from the hot springs at the Bay of Islands,

* Trans. N.Z. Inst., I., p. 71.

contributed by Mr. Hugh Carleton on the 8th June, 1869, has a weakly acid reaction. It has a strong odour of sulphuretted hydrogen, and is slightly turbid from the presence of liberated sulphur. A slight sediment had formed in it, which was separated from the portion analyzed.

The following is the amount and composition of the soluble matters contained in one gallon of it :—

Protoxide of iron	2·23
Lime	5·97
Magnesia	1·15
Silica	3·10
Sulphuric acid	13·60
Hydrochloric acid	66·91
Sulphuretted hydrogen	traces
Fixed alkalies	41·66
Ammonia	traces
Organic matter	„
	134·62

This water is evidently an acidulous one, and is a moderately strong chalybeate. I have not heard of its being medically tested, but it certainly should possess some therapeutic virtue.

A deposit formed by these springs has been also examined; it is a chocolate-coloured substance possessed of moderate coherence, and is spangled throughout with minute crystals of sulphur; reaction strongly acid.

APPROXIMATE ANALYSIS.

Sulphur	83·37
Siliceous matter	16·33
Soluble salts and acids	·30
	100·00

The soluble part when analyzed proved to be composed as follows :—

Sulphate of alumina	52·43
„ iron	traces
Sulphate of lime with a little sulphate of magnesia	27·60
Free hydrochloric acid	traces
„ sulphuric acid	11·32
Alkaline sulphates and loss	8·65
	100·00

4. *Alkaline Water.*

We now arrive at a water of a different kind from any of the preceding. It is an alkaline mineral water, and great interest in it was

taken by the local press at the time of its collection. It is from a spring at Hikutaia, Puriri, provincial district of Auckland; collected and contributed by Mr. Robert Kelly, on whose property it is situated, and was received at the laboratory on January 5, 1873. Waters of this kind are chemically distinguished by their more or less caustic taste, which they owe to the large quantity of fixed carbonated alkalies (principally of soda) that they contain.

They are used medically for the cure of gravel, kidney diseases, gout, acidity of stomach, etc.

The value of this water medicinally, as alleged by the Maoris, is no doubt due to the large amount of carbonate of soda which it contains, as iodine only exists in very small quantity, and I have not succeeded in determining the presence of any other substance known to possess (as a component of mineral waters) specially medical qualities.

In the annexed analysis the composition of the fixed matters present in one gallon of this water is stated in grains:—

Soda	199·010
Potash	2·587
Lime	11·088
Magnesia	8·008
Iron	traces
Silicic acid	2·772
Sulphuric acid	2·903
Carbonic acid }	300·438
Phosphoric acid }	a little
Chlorine with iodine traces	13·313
	540·119

These constituents permit of being arranged as follows:—

Chloride of sodium	21·938
Iodide of magnesium	traces
Sulphate of soda	·940
„ potash	4·938
Carbonate of iron	traces
Bi-carbonate of lime	28·506
„ magnesia	25·625
„ soda	452·393
„ lithia	traces
Silica	2·772
Phosphoric acid	not determined
	537·112

It should be stated here that the amount of carbonic acid given in the above analysis is merely computed, sufficient of it being taken to make up all the substances in union with it to bi-carbonates. Besides the acid necessary for this, there is a considerable quantity present in a free state: indeed, the water is, I believe, described as effervescing strongly when escaping from the spring.

This water is clear and sparkling, caustic as before observed, and has a specific gravity of 1006·46 at 60° Fahr.

Exposed to the atmosphere a crystalline precipitate formed, consisting principally of carbonate of lime, the following being its approximate composition :—

Carbonate of lime	81·21
„ magnesia	18·79
Iron oxide	traces
	100·00

I append an excellent and very elaborate description which has been published of this mineral spring :—

"About a mile and a-half from Say's, there may be seen an interesting mineral spring, which will well repay a visit. As we are not aware that it has ever been described, we devoted some time to its examination. On approaching the spring from Say's, a white, somewhat elevated patch strikes the eye. At a distance of half a mile it is very conspicuous in the surrounding fern and swampy land, and looks not unlike a deposit of guano as seen sometimes on the coast. Turning aside to inspect, a few yards through the fern on the left-hand side of the track, we found ourselves on a hard, whitish, oval-shaped mound of calcareous matter, about fifty feet in length and thirty-five feet wide, and of generally level surface. The western end of the ellipse slopes gently away to some low, boggy land, green with raupo, toetoe, and convolvulus. The other end is level with the harder and higher ferny surface of a low, flat spur from the neighbouring ranges, and at this end is an oval-shaped hole, about six feet by five, and three-and-a-half feet deep, but contracting regularly downwards like a funnel. The bottom is a mere tube of about three inches in diameter, down which a stick was thrust to a depth of eight feet from the surface. This hole is full of cold, clear, bubbling water, which overflows by a gutter about two inches deep and three inches wide, sunk in the hard crust of the mound and coursing outwards to its western extremity, where the small rill of water loses itself in the swamp below. Bubbles of gas continuously ascend in three or four columns from the bottom of the hole, and burst on the surface in rapid succession. The water has the pleasant, brisk, and

alkaline taste of soda-water, and has evidently built up, by its continuous depositions of the calcareous matter which it holds in solution, the whole of the white-crusted mound which surrounds the pool.

"It may assist the imagination of the reader if he fancy a painter's palette, magnified to a diameter of fifty feet and placed on a low piece of New Zealand swamp and fern. The palette will represent the white mound formed by the calcareous incrustation, the thumb-hole, the bubbling spring. A wavy line drawn from the thumb-hole to the further extremity of the palette is the gutter by which the overflow escapes.

"The deposit from the water is of two distinct kinds—the principal calcareous, and forming the bulk of the surrounding incrustation; the other is soluble in water, has a caustic taste, and is found only during dry weather as a recent white efflorescence caused by exposure to the air, or as little starry groups of crystals in the water of the gutter (soda ?). The water is highly charged with carbonic acid gas—as much as five ounces by measure of this gas having been obtained from a soda-water bottle full of the water. That both water and carbonic acid gas (otherwise 'foul air' or 'choke-damp') exist deep in the earth's crust, is a fact well-known to every miner on the Thames. Deeper still than our mines have penetrated, what water there is must be under a great pressure, and thus rendered capable of absorbing a very large quantity of the gas. When thus supercharged with gas, it has the faculty of dissolving carbonate of lime in considerable quantity, and if it comes in contact with that substance underground will rapidly take it into solution. Suppose now the water, charged to excess with carbonic acid gas, and thereby holding carbonate of lime in solution, to force its way to the surface of the ground: The pressure is taken off; the gas escapes bubbling at the spring; and since the lime can no longer be held dissolved, it deposits itself wherever the decarbonized water runs from its fountain. Such a deposit is formed in New Zealand around many a less fascinating spring than that of Puriri, and we have found at such places mossy and other incrustations which rival the similarly grown travertine of Europe. Three other little bubbling springs were found in the immediate vicinity, all very small, and not one having any zone of incrustation.

"Until a proper chemical analysis shall have been made, it is impossible to form an opinion of the value of this spring as a medicinal agent. That its mineral, gaseous, and other constituents possess some valuable properties, I should think there can be little doubt; and when these are better known it is possible that the medical men of the Thames and elsewhere may be not unwilling to recommend its use to their patients in certain diseases for which it may be found beneficial."

5. *The Waiwera Hot Springs.*

These springs, now deservedly in such repute, were sampled for the Laboratory here so far back as January 26th, 1873, by Mr. Hardy; and this sample *(a)* was about that time analyzed, that is partially so, the result being as follows, stated in grains per gallon :—

Organic matter	1·70
Chloride of sodium	112·32
,, potassium	1·46
Carbonate of lime	·82
,, magnesia	·41
Sulphate of lime	·73
Silica	2·70
	120·14

This water as received was clear, and with a slight alkaline reaction.

Since this analysis was made quite a large supply of this water has been presented by His Excellency the Marquis of Normanby, and upon this *(b)* a full analysis has been made. It is considerably more saline, as will be seen, than the former sample, so much so that it manifests a distinctly saline taste when applied to the palate. In other respects, however, it possesses similar characters.

The quantity of fixed matter present in a gallon of it is 219·495 grains, divisible as follows :—

Chloride of sodium	116·715
,, ,, potassium	·091
,, ,, lithium	traces
Iodide of magnesium	traces
Sulphate of soda	·383
Bi-carbonate of soda	87·513
,, ,, lime	10·692
,, ,, magnesia	·954
,, ,, iron	·683
Alumina	traces
Silica	2·464
	219·495

This water is of the same kind as that from Puriri, in the same provincial district, but is only of about half its strength. It compares most nearly with the famous continental waters of Vichy in France and Fachingen in Nassau, both of which are largely used medicinally.

I find that Dr. J. Carey has given a testimonial to Mr. R. Graham, of Auckland, in favour of this water, which is to the following effect :—" Having

observed during my stay at Waiwera the good effects produced by the use of the water, both by drinking and bathing, I am convinced of its efficacy in many disorders, more especially in rheumatism, scrofula, and gout."

6. *A sample of Water from Aorangi.*

This water was despatched here by the late Sir Donald McLean, for the purpose, I believe, of having an opinion as to whether it is a mineral water in the popular sense of the term. The characters of it are—colour, pale yellow; tasteless; odourless; weakly saline.

The following is the composition of the solid matters therein, calculated in grains per gallon:—

Chloride of sodium	1·87
Sulphate of soda	1·08
Carbonate of soda	1·81
" lime	1·76
" magnesia	·81
" iron	·94
Silica	1·56
Organic matter	3·92
	13·75

The carbonates are calculated as neutral or mono-carbonates, but there is a considerable quantity of carbonic acid present in the water beyond what is required for this.

From this it appears that the water can hardly be a mineral one, and if it has therapeutic qualities at all, they must be of a very feeble kind. Date of receipt, December 12, 1874.

7. *Water averred to be of a poisonous nature.*

Taken from a spring near Rangitaiki River, Bay of Plenty, and contributed by A. P. Seymour, Esq., 14th April, 1868, was found to be slightly turbid and of a faintly sour and styptic taste, with the odour of sulphuretted hydrogen. The quantity was too small to admit of a complete analysis being performed upon it. The total quantity of fixed matters found to be present in the water was 8·19 grains per gallon. They chiefly consisted of alkaline and earthy silicates.

The water was especially examined for mineral substances of a poisonous nature, and the only one partaking of this quality is the gas instanced—sulphuretted hydrogen. Assuming this to be the substance producing the symptoms of poisoning stated, the fact of the water becoming innocuous on exposure to the air can be explained by the circumstance that this gas would soon remove itself or oxidize to an innocuous compound.

8. *Acidic Mineral Water from White Island.*

Was collected by the Survey in 1868. As received it was colourless and

transparent. A slight sediment had formed which mainly consisted of gypsum in crystalline forms. Its specific gravity is 1·088 at 60° Fah., and the total amount of dissolved matter present to the gallon is 13,638 grains, which is made up as follows:—

Sulphate of iron (proto)	1059
„ soda	658
„ potash	275
„ lime	235
„ magnesia	60
„ alumina	80
Chloride of alumina (sesqui)	1703
Siliceous matter	21
Hydrochloric acid, free	9547
	13,638

This is therefore shown to be a highly saline water, and charged with free acid to such an extent as in all probability will render it useless for medical purposes.

A full description of the mode of occurrence of this water and the geological structure of White Island have been given by Dr. Hector.*

9. *Acidulous Mineral Water.*

The water of a small lake—Waimangeao—near Patauki, Mount Edgecombe, is considered to be of a poisonous nature, owing to the fact that birds frequently fall into it when attempting to fly across.

The sample of it which I had was not sufficient to allow of its complete analysis; it was forwarded by Mr. J. C. Young on the 31st of December, 1878.

Characters as follows—Clear and tasteless and of a weak acid reaction. A red deposit had formed consisting of iron oxides, combined with organic matter. The water separated from this deposit yielded 11·084 grains of solid matter per gallon, and it contained a large quantity of carbonic acid besides to which its acidity is due. These solid matters had the following composition approximately:—

Organic matter	2·956
Alkaline chlorides with carbonates and traces of sulphates ..	4·928
Sulphate of lime and magnesia	·246
Silica	2.954
Iron oxides	traces
	11·084

* Trans. N.Z. Inst., III., 278.

From this analysis, etc., it appears the water itself is innocuous as a beverage, but is heavily charged with a gas which is poisonous when inhaled, and which, as it escapes, poisons the air above, hence the effect of this air on birds immersed in it.

10. *Mineral Waters of the Rotorua District.*

A very interesting series of waters has now to be described. They were obtained from the famous geysers and hot water springs of Rotorua by Captain Mair, at the suggestion of His Excellency the Marquis of Normanby, and are reported on in the "New Zealand Gazette" of the 3rd May last.

These waters are fifteen in number, and, as will be seen, while they are generally characterized by the highly siliceous nature of their saline matter, they divide as to their medicinal qualities into two classes.

In the following account of the results obtained, I copy the temperature of the several springs to which they refer, as also the physical description of these springs, from the notes of Major Mair, which were attached to the schedule forwarded with the water.

The quantitative results are stated in grains per gallon.

No. (1)—Is the water from Te Tarata, or the spring which forms the great white terrace of Rotomahana. This is a true geyser, having a large crater-shaped basin 90 feet in diameter, the lip of which is about 70 feet above the level of the lake.

This basin is emptied by an explosive effort, which throws the water to a height of 40 feet, emptying the basin, which again fills up rapidly. The water trickles over the ledges of the terrace, depositing fresh layers of siliceous sinter as it cools in its progress to the lake. The water in the basin has a deep azure blue colour, and a temperature of 210° Fah.

As received at the laboratory, it was faintly turbid, but without any deposit, colourless, and having an alkaline reaction.

Analysis.

Silicate of soda	68·48
Mono-silicate of lime	1·62
" magnesia	·58
" iron	·51
Sulphate of potash	—
" soda	7·84
Chloride of potassium	2·87
" sodium	62·61
Phosphate of alumina	traces
Lithia	"
	144·46

All but soda are mono-silicates, the little excess of silica, 7·66, is included in the soda-silicate.

No. (2)—From Ta-pui Te Koutu, three-quarters of a mile from Ohinemutu, a large pool, 60 to 80 feet deep. The usual temperature of the water in this pool is from 90° to 100°, with westerly or southerly winds; but if the wind changes to N. or E., the water rises four feet in level, and the temperature increases to 180°, with a strong outflow. Thick masses of slimy Confervoid plants line the bottom of the pool. As received, the water was clear and colourless, with an alkaline reaction.

Analysis.

Silicate of soda	32·12
Mono-silicate of lime	1·62
" magnesia	·40
" iron	·67
Sulphate of soda	7·06
Chloride of potassium	·97
" sodium	29·94
Phosphate of alumina	traces
	72·78

Excess of silica over what is required to pass these bases as mono-silicates is 5·55.

No. (3)—From Turi-kore or Whakarewarewa, 2¾ miles from Ohinemutu. The sample was taken from a waterfall which drains from a large pond 300 yards long, the reservoir of a number of boiling springs that are in continual activity. The temperature of this fall is from 96° to 120°. The water is of a dirty brown colour, and is in great repute among the Maoris for the cure of all cutaneous diseases. As received, it was clear and colourless, with a faintly acid reaction, which changes to alkaline on boiling the water.

Analysis.

Silicate of soda	16·32
" lime	1·61
" magnesia	1·14
" iron	·39
Sulphate of soda	13·47
Chloride of potassium	1·24
" sodium	53·61
Phosphate of alumina	traces
	87·78

No. (4)—From Kuirua, in the native village of Ohinemutu, on the shore of Rotorua Lake, where a strong stream flows from a number of hot springs which cover an extent of about 30 acres. This has a temperature of from 136° to 156°, and is so soft that clothes can be washed in it without the use

of soap. It deposited a white flocculent sediment in the bottles, leaving the water clear, with a faint yellow tint, and an alkaline reaction.

Analysis.

Mono-silicate of soda	2·57
„ lime	·84
„ magnesia	·12
„ iron	·81
Sulphate of soda	10·31
Chloride of potassium	2·08
„ sodium	45·70
Phosphate of alumina	traces
Silica, free	18·42
	79·85

No. (5.)—From Koroteoteo, or the "Oil Bath," at Whakarewarewa.—This is a strong boiling stream, the recorded temperature being 214° from two springs, one of which, surrounded by beautiful sulphur incrustations, throws a powerful jet to a height of 20 feet. The water is distinctly alkaline, or slightly caustic, which is probably the reason for it being termed an "oil bath."

Analysis.

Mono-silicate of soda	2·08
„ lime	3·16
„ magnesia	·76
„ iron	·85
Sulphate of soda	7·49
Chloride of potassium	1·46
„ sodium	66·34
„ lithium	traces
Silica, free	22·40
Phosphate of alumina	traces
	104·54

No. (6).—Otukapuarangi, the "pink terrace" of Rotomahana. This terrace has been built up round a great circular pool 180 feet in diameter, from which there is a strong outflow of clear bright water, having a temperature of 204° to 208°, and depositing siliceous sinter of a delicate pink tint in large quantities. As received, the water was faintly acid, changing to alkaline when boiled.

Analysis.

Silicate of lime	1·91
„ magnesia	1·16
Chloride of potassium	1·05

Analysis.—*continued.*

Chloride of sodium	93·55
Sulphate of lime	10·96
" soda	1·01
Alumina as phosphate	·54
Silica, free	43·95
Iron oxides	traces
	154·13

No. (7.) Manupirua, on the S.E. shore of Rotoiti, a beautifully clear pool 20 feet in diameter, having a temperature of 107° to 110°, at the foot of a high pumice cliff on the shore of the lake. The water is clear, with a bluish tinge, harsh to the touch, and deposits sulphur. This pool has a strong outflow of 40 to 50 gallons per minute, and is reported to have great curative properties.

Analysis.

Mono-silicate of lime	1·51
" magnesia	·77
" iron	·99
Sulphate of soda	11·50
" lime	2·43
Chloride of potassium	·47
" sodium	6·25
Silica, uncombined	8·53
	32·45

No. (8.)—From Te Kauwhanga, 1½ miles from Ohinemutu, a powerful sulphur bath, having a temperature of 204°. The water as received was clear and colourless, with a distinct acid reaction, and evolving an offensive odour; it deposited a brownish sediment on being boiled. This bath is reputed to have great curative properties, and is known to tourists as the "Pain-killer."

Analysis.

Sulphate of potash	2·96
" soda	34·37
Chloride of sodium	59·16
" calcium	3·33
" magnesium	1·27
" iron	·25
Phosphate of alumina	traces
Silica	16·09
Hydrochloric acid	7·60
Sulphuretted hydrogen	2·01
	127·04

No. (9).—Cameron's Bath, situated in the same locality as No. 6. It is a muddy pool, 20 feet in diameter, having a temperature of 109° to 115°, but kept in a state of ebullition by a powerful escape of gas, which causes faintness when inhaled. The pool has no outflow, and the water is a dirty chocolate colour. As received, the water had a persistent acid reaction and offensive odour; it had deposited a siliceous sediment in large quantities.

Analysis.

Sulphate of potash	·94
" soda	83·47
" alumina	traces
" lime	2·11
" magnesia	1·14
" iron	1·20
Phosphate of alumina	traces
Sulphuric acid, free	76·79
Hydrochloric acid, free	7·28
Sulphuretted hydrogen	·41
Silica	7·01
	180·35

No. (10).—From Perekari, 1¼ miles from Ohinemutu. Temperature of water 130° to 150°. A boiling pool in a sand-spit near the lake, in which the water is discoloured, and has a very offensive smell. As received, it was clear and colourless, with a strong acid reaction; it had deposited a great deal of sediment, which consists of nearly pure silica.

Analysis.

Sulphate of soda	26·75
" alumina	traces
" lime	2·45
" magnesia	1·86
" iron	·76
Chloride of potassium	·63
Phosphate of alumina	traces
Hydrochloric acid, free	5·38
Silica	18·17
	56·00

No. (11).—From Te Kauwhanga mud bath, 1¼ miles from Ohinemutu. A thick, brown, muddy water, covered with an oily slime, and having a temperature of 80° to 100°. When received, it had deposited a heavy muddy sediment, and had a persistent acid reaction, and an offensive odour.

Analysis.

Sulphate of potash	·77
" soda	23·71
" alumina	1·46
" lime	2·04
" magnesia	1·62
" iron	1·47
Phosphate of alumina	traces
Sulphuric acid, free	7·60
Hydrochloric acid, free	7·66
Sulphuretted hydrogen	3·19
Silica	13·86
	63·38

No. (12).—From Ariki-kapakapa, 2 miles from Ohinemutu, a small pool with a strong outflow, having a temperature of 160°. It deposits sulphur, and is surrounded by a great number of other baths and mud volcanoes. It is reported to have powerful curative properties. It was colourless as received, with a heavy deposit of silica, and an acid reaction, which was permanent at its boiling point.

Analysis.

Sulphate of potash	·38
" soda	12·51
" alumina	·68
" lime	2·21
" magnesia	1·29
" iron	3·15
Phosphate of alumina	traces
Sulphuric acid, free	13·95
Hydrochloric acid, free	2·62
Silica	18·15
	54·94

No. (13).—Sulphur Bay Spring, on the edge of Lake Rotorua, formed by innumerable small jets forced up through sand, having a disagreeable odour, and a temperature from 90° to 100°. This bath is reported to have a powerful action on the skin, owing no doubt to the large quantity of sulphuric acid it contains. As received, it was colourless, with a slight flaky sediment.

Analysis.

Sulphate of potash	·07
" soda	8·37
" lime	2·50
" magnesia	·93

Analysis—*continued.*

Sulphate of alumina	traces
„ iron	2·68
Phosphate of alumina	traces
Sulphuric acid, free	18·02
Hydrochloric acid, free	·86
Silica	10·08
Sulphuretted hydrogen	1·01
	44·52

No. (14).—From Ti Kute, the "Great Spring," 10½ miles from Ohinemutu, a pool three-quarters of an acre in extent, having a temperature varying from 100° to 212° in various parts. It boils furiously, and dense volumes of steam are continually rising from it. The water is of a muddy brown colour, and contains a large proportion of sulphuretted hydrogen, and is reported to be wonderfully efficacious in cases of rheumatism and cutaneous disease.

Analysis.

Sulphate of potash	·59
„ soda	12·66
„ alumina	11·22
„ lime	1·01
„ magnesia	·69
„ iron	1·73
Phosphoric acid	traces
Sulphuric acid, free	·77
Hydrochloric acid, free	1·63
Sulphuretted hydrogen	5·74
Silica	12·40
	48·44

No. (15).—From Te Mimi, Okakahi, a waterfall having a temperature of 90° to 112°. It drains from the preceding (No. 14), and only differs from it in being more dilute, and having a larger proportion of sulphuric acid, and less sulphuretted hydrogen.

Analysis.

Sulphate of potash	·13
„ soda	4·78
„ alumina	traces
„ lime	2·04
„ magnesia	·93
„ iron	·23
Phosphate of alumina	traces
Sulphuric acid, free	12·48

Analysis—*continued.*

Hydrochloric acid, free	3·82
Sulphuretted hydrogen	·98
Silica	4·12
	29·51

I give below in a tabular form the respective quantities of the several substances found to be present in a gallon of each of these waters:—

No.	Temperature.	Silica.	Iron Oxide.	Alumina.	Lime.	Magnesia.	Soda.	Potash.	Lithia.	Sulphuric Acid.	Chlorine.	Sulphuretted Hydrogen.	Total Contents.
	Deg. Fah.												
1	210-214	89·31	·30	·02	·77	·21	67·10	1·81	*	4·42	39·36	..	153·30
2	90-180	20·18	·30	·01	·77	·12	32·37	·61	..	8·98	18·63	..	76·97
3	96-120	13·63	·20	·01	·77	·45	39·84	·81	..	7·59	33·18	*	96·48
4	136-156	20·09	·10	·07	·16	·07	30·01	1·31	..	5·81	28·72	..	86·34
5	214	25·72	·46	*	1·24	·30	39·47	·91	*	4·22	40·96	..	113·28
6	204-208	45·66	*	·54	5·54	·46	50·01	·66	..	6·33	57·27	..	166·47
7	107-110	10·31	·40	·06	1·41	·31	8·33	·30	..	7·91	4·01	*	33·04
8	201	16·09	·14	*	1·68	·62	46·36	1·60	*	20·72	46·72	2·01	135·94
9	109-115	7·01	·54	*	·81	·38	14·61	·51	..	98·72	7·08	·41	130·07
10	130-150	18·17	·30	·04	1·01	·62	12·59	.39	..	18·16	6·21	..	57·49
11	80-100	13·86	·70	·38	·84	·54	10·35	·42	..	25·41	7·15	3·19	63·17
12	160	18·15	1·49	·20	·91	·43	5·46	·16	..	25·44	2·53	..	54·77
13	100-212	10·08	1·27	*	1·03	·31	3·94	·04	..	26·04	·81	1·01	44·56
14	90-100	12·40	·82	4·91	·83	·23	5·53	·32	..	19·49	1·59	5·71	51·86
15	90-112	4·12	·10	·05	·84	·31	2·09	·07	..	17·22	3·72	·98	29·50

NOTE.—The phosphoric acid present is omitted from this table, but appears in the detailed account of these waters.

* Traces.

None of them in their natural state gave any indication of the presence of either iodine or bromine, nor were any such indications observed for those waters which, for more rigorous testing, I evaporated to a small bulk. The waters I thus treated especially for these elements are Nos. 1–6 and 10–14, and as they represent all the kinds of waters of this series, I think it may be safely concluded that these substances are either absent, or, if present, are in quantities so small that they will not exercise any appreciable effect upon any one using these waters.

The metal lithium was found in waters Nos. 2, 7, and 9, but only in such small quantity as not to be readily detected, except spectroscopically.

As this is a substance having active medical properties, even when administered in small quantities, if *continuously*, it is often an important matter that its presence in any mineral water should be known to those who use it.

A perusal of these analytical results will show that the waters in question belong to two distinct classes—the alkaline and acidulous.

The *alkaline* ones differ from those of this class which have been already described in being silicated instead of carbonated. They are, in fact, eminently siliceous waters comparing with the hot spring water of Iceland; any carbonic acid which may have been present in the water when situated at a great depth, being eliminated therefrom as it reached the surface, in consequence of the superior affinity of silicic acid for alkaline bases at elevated temperature and low pressure.

This substitution of silicic for carbonic acid will only affect the waters for therapeutic purposes where they depend in part or wholly for their desired effect upon the presence of carbonic acid. When the alkaline character of the water, however, is alone to be regarded, I do not see why these silicated waters of ours should not (when of about the same strength) be quite as useful as those alkaline waters of the European spas in which the alkalies are combined with carbonic acid, and when neither iodine nor lithium are present to any notable extent. The waters of this kind are Nos. 1–6.

The waters of the other class—the *acidulous*—are also remarkable as being those from which carbonic acid has been wholly eliminated; but in this case a so-called mineral acid, hydrochloric or sulphuric acid, is the substituting one in place of silicic acid as in the waters of the former class. Silicic acid is, however, generally present, but in a free state as a hydrate, all the silica which is entered in the analytical results of these waters being of the kind known as soluble silica. The waters of this class are Nos. 8–15. Certain of these are hepatic, some strongly so, that is, they contain sulphuretted hydrogen in quantity, and it is only the waters of this kind which it would be safe as yet to look upon as having useful medicinal qualities to a remarkable degree.

These waters are Nos. 8, 9, 11, and 13–15, or those of Kauwhanga, Cameron's Bath, Te Kauwhanga, Sulphur Bay Spring, Ti kute, and Te mimi, Okakahi, respectively.

These waters should prove efficacious in cases of rheumatism and skin diseases. The more palatable ones will of course be those which are the least acidic.

I cannot find that these waters strictly compare with any of those afforded by the European spas; the free hydrochloric or sulphuric acid present in them clearly separating them therefrom.

11.—*Taupo Mineral Waters.*

I now have to describe a series of twelve waters from various hot springs in the provincial district of Napier, which were presented to this department in June, 1878, by Dr. W. I. Spencer.

Only two of these interesting waters have as yet been fully analyzed, they are Nos. (11) and (12); the former, from the Hot Springs of Tarawera, contains a considerable quantity of free hydrochloric acid, its principal constituent being sodic-chloride.

The other water (No. 12) is from Parkes' Spring, Taupo, and is the most saline water of this series; it contains, besides, much silica.

Both waters are rich in iodine.

Subjoined are the results of these analyses, stated in grains per gallon.

—	TARAWERA, No. 11.	PARKES' SPRING, No. 12.
Chlorine, with bromine traces	40·497	56·076
Iodine	·714	1·012
Sulphuric acid	2·150	2·156
Silica	2·221	16·752
Carbonic acid	traces	*35·751
Alumina	·621	..
Iron	1·049	..
Lime	2·036	1·994
Magnesia	·492	·613
Potash	3·681	5·675
Soda	46·495	80·710
Lithia	traces	traces
Phosphoric acid	..	..
	99·956	200·739

* The carbonic acid in No. 12 is that which is in a combined form; there is, besides, a quantity of this acid in a free state.

It will be gathered from these results that the Tarawera water is distinctly an aluminous one, that is, it contains alum in some quantity, and is fairly rich in iodine. It has but few representatives in Europe. One of these is the Labassère (Hautes Pyrénées) which is drunk for bronchial and laryngeal catarrh. The strength of this water, however, is only about one third that of ours.

The other water, that from Parkes' Spring, Taupo, is of very much the same character as that from the Waiwera Hot Springs, but is far richer in iodine; it bears a great resemblance to the mineral water of Luhatschowitz, in Moravia, which is useful in chronic bronchial catarrh, especially if combined with scrofulous complaints, and in congested liver and hemorrhoids arising from sedentary habits.

The samples from the other springs have been examined so far that their general character has been ascertained. The results will be found in the table given on the next page, computed in grains per gallon.

It should be stated that all these samples of mineral waters gave evidence of the presence of sulphuretted hydrogen, but as they were enclosed in corked bottles, the quantity of this gas naturally existing in them could not be ascertained, organic matters, such as cork, being able

to generate sulphuretted hydrogen from aqueous solutions of the sulphates when in contact with them—a circumstance I note here especially for the guidance of collectors of mineral waters for analysis.

No.	Salts soluble in water. Principally alkaline chlorides.	Salts soluble in acids. Principally sulphate of lime.	Silica.	Total of Salts.	Loss by ignition.	Physical character.	Reaction.
1	5·28	·74	7·86	13·88	3·47	pale yellow, clear	faintly acid.
2	13·88	4·31	9·25	27·44	3·08	colourless, clear	,,
3	3·85	1·69	2·94	8·48	1·54	,, ,,	,,
4	138·07	4·21	10·03	152·31	3·09	,, ,,	,,
5	64·72	1·63	18·51	84·86	12·97	yellow, turbid	,,
6	8·13	9·24	15·75	33·12	1·52	colourless, clear	slightly acid.
7	24·12	3·84	28·51	56·47	3·24	,, ,,	,,
8	127·62	9·62	6·25	143·49	4·61	,, ,,	neutral.
9	6·16	3·08	12·33	21·57	4·65	pale yellow	slightly acid.
10	3·09	4·62	6·10	13·81	3 08	colourless, turbid	,,
11	..	..	2·22	99·95	..	,, clear	very acid.
12	..	..	16·75	200·73	..	,, ,,	faintly acid.

In the following schedule the localities of these waters are stated, together with certain interesting particulars respecting them which have been furnished by Dr. Spencer. The general character of each, as deduced from the foregoing table, is also given :—

No. (1).—Otumuheka Spring; collected 1st March, 1873; a siliceous water, more than half its solid matter being silica; the remaining portion is principally chloride of sodium with a notable quantity of iodides.

No. (2).—From same locality; collected same time as above, and is also a siliceous water, but although it contains a larger proportion of alkaline chlorides than this water, it gives but slight indications of iodine.

No. (3).—From the Otumuheka Stream. This stream has a temperature of 78° Fahr., and forms bathing places at Lake Taupo. It is a very similar kind of water to No. (1), and, like it, is rich in iodine.

No. (4).—From the Ruahine Hot Springs, on ground belonging to Mr. Locke. These springs have a temperature as high as 190° Fahr. They are eminently saline, the principal constituent being chloride of sodium, and appear by comparative tests to be the richest in iodine of any of this series of waters; collected 1st May, 1873.

No. (5).—From the baths of Orakeikorako. As received this was very turbid and high coloured. It did not lose its turbidity when allowed to be at rest for a long time. It is highly charged with saline matters, principally alkaline chlorides, and it gives a very distinct reaction of iodine. The organic matter is high in this water.

No. (6).—From a bath named after Mr. McMurray. Is a siliceous water, comparatively poor in chlorides, but rich in iodides.

No. (7).—From the alum caves at Orakeikorako, collected 1st May, 1878. Differs from any of the preceding waters in containing a large quantity of sulphate of lime. It gives evidence of possessing only traces of iodine.

No. (8).—From the Crow's Nest, collected 1st May, 1878. Temperature of spring 179° Fahr., similar to No. (4). Quantity of iodine present is very minute, but still can be detected in it as unconcentrated.

No. (9).—From Waipahahi. Forms a pool 50 by 30 yards, the native name of which is Koneckeneke. It has a rocky bottom and forms a fine swimming bath. Temperature of water varies from 98° to 120°; collected 1st May, 1878. This is a *siliceous water*, from which iodine appears to be absent; at least this element could not be detected in it when concentrated to one-fifth of its original bulk.

No. (10).—From a hot spring on the Oranui block—Te Hukahuka. Forms a bathing place 15 by 10 feet. A cold water creek and hot springs issue from its enclosing rocks at side and bottom. This resembles the spring water of a slate country except that it is largely charged with iodine; collected 1st May, 1878.

From the above tables and schedule it will be seen that we have several kinds of mineral waters here, both hot and cold, within no great distance of each other, which is a circumstance likely to be of considerable advantage to many who may desire to use mineral waters for their health.

It is to be observed that while there is this difference in the constitution of their saline constituents they nearly all contain iodine in sufficient amount to impart to them very decided therapeutic properties. This substance, it may be stated, has been proved to be very efficacious when externally applied in cases of cutaneous eruptions.

I should state that so far back as July, in 1871, I partially analyzed a water (contributed by Mr. Murray Gibbs) from Haweraroa, Tarawera district, but whether taken from the same spring as No. (11) was, or from a hot spring at all, I have no information. However, it is essentially an acidic water like No. (11). As received it was opalescent, of a weak reddish-blue colour, and had an odour of sulphuretted hydrogen. This opalescence is due to the presence of hydrated silica, which in a minutely divided or gelatinous form is transfused throughout the liquid.

The free acid present is principally or wholly the hydrochloric.

11a. *Hepatic Mineral Water.*

A water collected by Dr. Hector, from Burton's Taipo, is strongly hepatic. Besides the sulphuretted hydrogen which gives it this quality, it contains the other characteristic substances—arsenic and iodine—both, however, in small quantity. It is slightly acid, but acquires a strong and persistent alkaline reaction when evaporated to a small bulk.

In obtaining these data, I unfortunately exhausted my stock of this water.

12. *Water from spring on west side of Waikato River.*

A water from a hot spring near a lake on the west side of Waikato River, Auckland, contributed by Mr. Justice Gillies, 23rd September, 1868, is clear, of a decided alkaline reaction, contains 47·04 grains of fixed matters to the gallon consisting principally of alkaline chlorides, the remainder being chiefly silicate and sulphate of lime with alkaline carbonates. There was not sufficient of this sample to allow of a complete analysis of these fixed matters.

The following is Captain Hutton's description of this spring—"It was about four miles from Lake Wangape in the Waikato. There were several hot springs close together, but this was the largest of them being fifteen yards long by five yards broad, and it was very deep; the water was so hot that it was impossible to bear the hand in it for more than a second, and on one occasion when he was in company with others, having caught a pig for dinner, they fastened it with flax and threw it into the spring, and on taking it out it was perfectly scalded and they had no difficulty in scraping the hair off; the temperature of the spring was from 160° to 200° Fahr. at the very least. The water itself was almost tasteless; he had drunk it himself. He thought it was the carbonate of sodium which gave it an alkaline reaction. What its effects would be as a mineral spring he could not say; but it was easy of access; was very prettily situated, and was not more than 50 miles from Auckland, and he trusted that some day it would be called into use."*

13. *Wallingford Mineral Water.*

The first water which I have to notice, as coming from the provincial district of Wellington, is one from Wallingford; contributed 15th June, 1866. As only a few ounces of it were at my disposal, I have only been able to determine its character and the proportion of the saline matter contained therein. It is faintly acid; has a pure strong saline taste, and is somewhat turbid from the presence of aluminous substances. The total quantity of fixed salts present in a gallon of it is 826 grains. They are mainly composed of alkaline and earthy chlorides. There are present also traces of certain bromides and iodides.

Dr. Grace subsequently handed in a water from about the same locality as the above. The two are similar, but the former is the richer in iodine.

14. *Mineral Water of Pahua.*

a. This is from a spring on Mrs. Sutherland's run, and is remarkable for the quantity of iodides and the comparative paucity of sulphates therein.

* Trans. N.Z. Inst., I., p. 71, ed. I.

The first time that this character of the water was elicited was in May, 1872, when I had a small phial of it presented to me by Mr. Douglas McLean, and in my official report thereon I stated that it gave a good reaction of iodine to the proper tests even when unconcentrated, a proof of the richness of any water in iodine, and that by chromatic tests it was ascertained the quantity of this element present in a gallon of the water would not be less than one grain. Further, I urgently requested a sufficiency of this water, to allow of a complete analysis being made upon it, and this I was promised; but the difficulties attending the transport of bulky parcels from these springs here for several years prevented this promise being fulfilled until April 16, 1877, when a large keg of this water *(b)* was delivered here by Mr. Alex. Sutherland, and I was then enabled to make a very full analysis of it, and note with considerable exactitude its general properties. It proved to be a clear and strongly saline water characterized by the presence therein of a very large proportion of sodic chloride, and an amount of iodine unusual for natural water, a considerable portion of which is very singularly in a free state. It manifests very distinct alkaline reaction, even at common temperatures and when unconcentrated. Lithia appears to be absent, at least I could not detect it, even spectroscopically, in the spirituous extract of the salts contained in half a gallon of the water.

The total quantity of matter which I have determined in one gallon of it is 1474·096 grains, the constitution of which I have made out as follows:—

Chloride of sodium	1303·329
„ potassium	·501
„ magnesium	34·960
„ calcium	120·885
Iodide of magnesium	·582
Bromide of magnesium	traces
Sulphate of lime	3·026
Phosphate of alumina }	·641
„ iron }	traces
„ lime	·480
Bi-carbonate of lime	6·451
Silica	1·696
Iodine, free	1·595
	1474·096

Total quantity of iodine to the gallon (free and combined) 2·127 grains.

This water appears to be therefore a strongly chlorinated one, unusually rich in iodine, and, as before stated, is remarkable, and I might almost say unique, in having a portion of the iodine in a free state. The last circumstance has induced me to request a further sample of the water, to be taken under especial precautions to avoid the introduction of anything into it

which would liberate this element. I may state here that I have not yet heard of the existence of free (native) iodine being authoritatively announced.

This water comes under the sub-class alkaline chlorinated water, and therefore resembles those of Wiesbaden, Kreuznach, and Aix-la-chapelle of the continental waters, and those of Cheltenham, Harrowgate, and Leamington of the English ones. It is, however, remarkable for its generally superior strength over the English water of this class, and therefore should manifest medical effects in a corresponding proportion when properly tested.

15. *Mineral Water from northern boundary of Wellington.*

Another water of the same class as the above, but one considerably less iodized, is that from a mineral spring occurring about the Wellington boundary of the run of Mr. Douglas McLean. Its characters are as follows:—Somewhat turbid, has a decidedly saline taste, and is feebly alkaline to test paper. Its principal constituent is chloride of sodium; it differs from sea-water, however, in containing a notable quantity of carbonate of soda; also in giving a very distinct reaction of iodine to the proper tests for this substance, even when these are applied to the water as unconcentrated. The following results of its analysis are expressed in grains per gallon:—

Soda	219·310
Potash	2·833
Lime	2·219
Magnesia	7·158
Lithia	traces
Iron oxides	1·481
Silica	6·418
Chlorine	240·362
Sulphuric acid	·715
Carbonic acid	18·444
Iodine and bromine	traces
	498·940

These results allow of being expressed in the following manner:—

Chloride of sodium	392·594
Chloride of potassium	4·448
Iodides and bromides	not estimated
Sulphate of soda	1·269
Carbonate of soda	18·604
,, magnesia	15·031
,, lime	3·961
,, iron	2·386
Silica	6·418
	444·711

This water, it will be observed, contains a notable quantity of carbonate of iron, a fact which confers upon it the additional character of a chalybeate, and therefore that of a tonic.

16. *Akitio Acidulous Mineral Water.*

This is the last water of the Wellington series I have to describe. The sample as received from Mr. Douglas McLean was very turbid, quite tasteless, and colourless when clarified. It is largely charged with free carbonic acid, and gives no reaction of iodine with the starch test when its salts are greatly concentrated.

The following are the results obtained by its analysis computed in grains per gallon:—

Silica	4·15
Iron and alumina	·93
Lime	13·14
Magnesia	2·32
Soda with a little potash *	4·68
Chlorine	1·84
Sulphuric acid	1·02
Carbonic acid, combined	9·57
	37·65

This water is therefore eminently a carbonated one containing lime as the principal basic substance of its salts.

It is decidedly chalybeatic and is very much of the same character as the water of Pyrmont (Waldeck) and Recoaro (Venetia).

17. *Nelson.*

The Hot Springs, Hamner Plains, Nelson, were sampled by Mr. W. T. L. Travers for the Laboratory, 5th April, 1869. The water is transparent, colourless, and tasteless, but decidedly alkaline to test paper even in its normal state. A flocculent precipitate had settled, principally silica, which amounted to 2·11 grains per gallon. The total of fixed matters present was 86·4 grains per gallon. Of this 2·88 grains were silica, the remainder being principally alkaline chlorides and carbonates.

18. *Canterbury.*

The water of certain thermal springs at the head of Lake Sumner, provincial district of Canterbury, has been partially examined, and with the following results:—Reaction faintly acid, colourless, and nearly transparent; total quantity of fixed matter present to the gallon 18·516 grains, which principally consist of alkaline chlorides. Contributor—Dr. Haast; date of receipt, 8th October, 1873.

* Not sufficient water to allow of its determination.

This water, therefore, appears of such a character that we can hardly expect it to have any marked therapeutic qualities. Though from a thermal spring I question the propriety of designating it as a mineral water, that is, in any special sense of the term.

19. *Southland.*

A water from Mr. Edmund Gibson's home station, Southland provincial district, was collected in January, 1875, by Mr. Charles Traill, who states that it is deemed a specific for diarrhœa. It is feebly but distinctly alkaline, is quite clear, and tasteless. Submitted to a partial analysis, it afforded me a quantity of fixed salts, equal to 18·516 grains to the gallon, and 7·5 grains of volatile substances (organic matter principally), the rest being ammoniacal salts. There was not sufficient saline matter afforded me to allow of their nature being exactly ascertained, but I observed a considerable quantity of ferric salts present in it; the bulk of these matters were, however, alkaline chlorides and carbonates. It will be observed that the organic matter is very high in amount, and it is to some astringent principle of this that I am inclined to attribute its potency as a specific for the ailment above-mentioned.

The comparisons with European waters given in this paper are founded on the information afforded in Mr. P. Squire's Companion to the British Pharmacopœia.

Art. LXVI.—*On the Result of an Examination of certain of our Manganese Ores for Cobalt.*

By William Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 12th January, 1878.*]

In June last I had to estimate the proportion in which cobalt existed in a variety of manganese ore from New Caledonia, known as asbolite. This one, though physically differing in no respect from several of our manganese ores, afforded me no less than 7·2 per cent of cobalt, a proportion which gives the mineral a considerable market value, cobalt being a comparatively rare metal, and one which is now in much request.

In consideration of this, therefore, I deemed it highly necessary that an especial examination should be made for small quantities of this metal in those of our manganese ores which compare most closely with this from New Caledonia, for it appeared to me as not at all improbable that a little cobalt might have escaped detection by analytical processes, the purpose of which had been merely to determine the fundamental character of the ore, and in such a case an opportunity might have been lost for guiding mining opera-

tions to the working of any payable cobaltic vein which such feebly cobaltic ore may indicate. I accordingly tested a number of our ores most likely for cobalt very rigorously, but I am sorry to have to inform you that the results obtained were in every case entirely negative. I do not mean to be understood by this as affirming the non-existence of cobalt in all these cases, but only that I could not find it by any ordinary course of analysis, and in consequence if it is present it can only be so in quantity so minute as to be of no indicatory value when found.

But although such is the character of my results I make no apology for bringing them under your notice, as I am under the impression that you will think it a serviceable act to make public in this way the fact that certain of our ores—greatly resembling the cobaltic ore, asbolite—are not cobaltic, and do not indicate the existence of such an ore in the neighbourhood they are in.

Those I have tested are from Wellington, Nelson, Marlborough, and Auckland.

All these are essentially hydrous oxides of manganese with varying proportions of iron oxide.

It will be very interesting for us to know the matrix of the New Caledonian ore and the geological character of the formation in which it occurs. I observe that the ore contains a little chromate of iron (crystalline), a fact which would seem to indicate that it occurs in some serpentine rock.

ART. LXVII.—*On the Solubility of Calcic Carbonate in Solutions of the Alkaline Chlorides.* By W. SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 12th January*, 1878.]

A SHORT time ago I had, in the course of my professional duties, to ascertain the reason why a rapid formation of sediment occurred within a locomotive boiler at Oamaru, the supply for which had been a hard water, upon which Clarke's softening process was applied before use.

This rapid formation of sediment is a very serious matter, and it was suggested to me that the process in question had not been properly worked in this case. A careful examination, however, of the lime-water used to soften the water, of the sediment, and of the water in its normal state, clearly showed me that no charge of this nature could be sustained.

The water proved to be not only a hard water in the sense of being very calcareous, but highly chlorinated too,—that is, one containing an alkaline chloride in quantity, and this fact viewed in conjunction with that of the imperfect operation of Clarke's process upon it led me to suspect that these chlorides can exercise a very decided solvent effect upon mono-carbonate of lime. That they have this effect was clearly shown by an investigation I carried out, and the result of which I now beg to lay before you as follows. First let me give an analysis of the hard water:—

Chloride of sodium	20·17
Sulphate of soda	1·67
" magnesia	4·30
Bi-carbonate of magnesia	4·01
" lime	10·82
Silica	3·65
	44·62

On behalf of any here who may have forgotten the mode in which Clarke's softening process effects what is desired of it, I will shortly describe it, as it is necessary to remember it in order that the bearing of the several statements to be made here may be fully apprehended.

This process then consists in applying lime-water to the water to be softened, by which all the lime existing therein in the form of bi-carbonate is brought into that of the mono-carbonate, and this compound being far less soluble in water than the original one, is in greater part precipitated.

The full meaning of the effects I proceed to state will now be readily gathered.

1.—A saturated aqueous solution of sodic chloride was mixed in equal volume with a strong solution of bi-carbonate of lime, and Clarke's softening fluid was added thereto in varying quantities until quite in excess. The liquid remained quite clear, and no precipitate formed in twenty-four hours.

2.—The same effects followed when either potassic or calcic chloride, potassic nitrate or sodic carbonate were substituted for the sodic chloride in experiment No. 1.

3.—The Oamaru hard water was mixed with sodic chloride at the rate of one pound to the gallon; the filtered solution when treated with lime-water in small or large quantity remained quite clear.

4.—The same water was charged with a slight excess of lime-water alone (sodic chloride being this time omitted) when an abundant precipitate formed. This precipitate, when analyzed and the results computed in grains per gallon upon the water taken, gave as follows:—

Carbonate of lime	21·75
Carbonate of magnesia	·81
	22·56

5.—Solid carbonate of lime (as limestone) having been placed in contact for twenty-four hours with a cold aqueous solution of an alkaline chloride was found to be dissolved to a far greater extent than it would have been by the same volume of pure water, and further, the saline solution of lime thus made rapidly deposited a very considerable portion of this earth when heated to about 180° Fahr. Carbonate of soda was found to have the same effect upon limestone as sodic chloride.

The results of the first two experiments clearly show the solvent effects of strong solutions of several saline substances upon bi-carbonate of lime as newly made. The results of experiments Nos. 3 and 4 show that a naturally hard water when charged to only a comparatively small extent with sodic chloride refuses to part with any of its lime when treated with Clarke's process; they show further a certain extent to which this retention of lime may occur, a matter which will be fully considered shortly.

The results of the last experiment are confirmatory of much which has been stated before, by demonstrating the fact that cold aqueous solutions of an alkaline chloride or carbonate can dissolve the solid carbonate of lime, and that high temperatures are inimical to the retention of the dissolved earth by such solutions. Where necessary the solutions were boiled prior to use in order to expel any carbonic acid present.

I should state here that the common test for lime—oxalate of ammonia—could not be successfully used in examining for lime in experiment No. 5, as oxalate of lime is also very sensibly soluble in salts generally; this manifested itself to me very early in these experiments, by the fact that water containing a trace of sodic carbonate but otherwise pure, after being boiled with limestone and treated with this oxalate, afforded no reaction of lime, although this body was proved to be present in quantity sufficient to afford a good indication with the oxalate were the soda absent. This salt is, indeed, very similar to the bi-carbonate in respect to solubility in saline solutions.

Of all the salts tested for a solvent property of this kind the fixed alkaline carbonates appear to possess it to the largest extent.

The greater solvency of calcic carbonate in cold solutions of certain salts is an interesting fact and one about which the following particulars should be given. The finely powdered calcic carbonate was digested with a solution of the salt (first previously boiled for twenty-four hours) at a common temperature in a vessel closed from the air. The solution rapidly filtered off, affording a very perceptible precipitate when treated with oxalate of ammonia, and a still greater precipitate when slightly warmed. Another portion of the calcic carbonate was digested for the same time in hot solution of the alkaline carbonate, but the liquor gave no precipitate with oxalate of

ammonia, showing very clearly that these saline solutions are more powerful solvents in this respect when used cold.

The exact quantity of calcic carbonate which a solution of any one of these salts of a certain strength can dissolve has not yet been ascertained, but the results of experiment No. 8 show a certain minimum capacity of sodic chloride in this respect. Thus it appeared by it that the highly calcareous Oamaru water, when charged with sodic chloride at the rate of one pound per gallon, does not afford any calcareous precipitate when submitted to Clarke's process. Now the total quantity of calcareous precipitate afforded me by this process as applied to the water in its normal state was no less than 21·75 grains to the gallon. Clearly then this quantity of calcareous matter (calcic carbonate) is retained by this water in a soluble form, showing a *certain minimum capacity* of the sodic chloride in this respect, a computation which may, however, be found to fall far short of that which represents its actual capacity when this shall be properly tested.

In conclusion, I would submit to you that these results show:—

1st. That Clarke's softening process cannot be advantageously applied to hard water containing alkaline salts in quantity unusually large for such waters.

2nd. That sea-water, containing as it does a very large quantity of these salts, has a considerable solvent power upon every limestone formation with which it is in contact; a fact which should, I conceive, be taken into account by geologists in connection with the erosion of these rocks by sea-water.

3rd. That the actual quantity of calcic carbonate present in one gallon of average sea-water may be considerably more than that which is now customarily assigned to it—viz., three grains to the gallon, as this quantity is merely got by a computation in which the solvency of the compound in *pure* water is taken as a guide; it is obvious, however, that an addition should be made to this, so that the quantity dissolved by the salts of this water may be included in the estimate.

Art. LXVIII.—*On the Degree of Solubility of certain Earthy Carbonates in pure Water.* By W. Skey, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 12th January,* 1878.]

The degree to which certain earthy carbonates are held to be soluble in pure water by those chemists who have studied this matter, is so variously and so divergently stated by them that, practically, we cannot rightly

consider this question to be settled, at any rate not authoritatively so; thus the degree of solubility of calcic carbonate in pure water, as assigned by Fresenius, is one part in 10,601 parts of water, and by Bloxham, one part in 85,000 parts, while one in about 23,000 parts is generally taken as the datum wherewith to compute the quantity of this compound present in sea-water, or about three grains per gallon.

Now these statements are, as you perceive, of a very conflicting character, and upon coupling the knowledge of this fact with that of the very decided solvent effects of many alkaline salts upon calcic carbonate (as shown in my last paper to this Society,* I became impressed with an idea that in the case of the earthy carbonates generally those results upon which the higher ratios of solubility were based had been vitiated by the action of one or more of such salts in the test liquid used, a certain quantity of the carbonate tested being dissolved thereby, which, added to that capable of being dissolved by pure water, raised the quantity dissolved to one proportionately greater than that proper to assign to such carbonates.

Under this impression I investigated the matter for myself, and whether my hypothesis be right or not, it was soon ascertained beyond doubt that these higher ratios are wholly erroneous, and not only this, but that even in most cases the lower ones are greatly over-stated.

The actual results of this investigation, together with the method used therein, I will now proceed to state as succinctly as possible.

First, then, as to the method:—

I make up a solution of the earth, the carbonate of which is to be tested, to a certain strength, as a chloride, also a very weak solution of carbonate of soda or of lithia. Both solutions are boiled for a long time to expel any free carbonic acid present, and afterwards allowed to cool to a common temperature. The solution of earthy chloride I then dilute with freshly distilled water applied successively in small and measured quantities, until the last portion sampled therefrom when mixed with the carbonate manifests but the faintest cloudy appearance (indicating a precipitate of carbonate) when viewed in a large bulk and after the lapse of a considerable time.

Now it is obvious that so long as the slightest cloud is formed under these circumstances, the whole of the earthy carbonate which is produced by the interaction of the salts used is not dissolved, a minute quantity being thrown out of solution, and so by computing the quantity of earthy carbonate present in a certain volume of the liquid we have an approximate estimate of the solubility in water of the earthy carbonate with which we

* *Vide* Art. LXVII.

are operating—an estimate which, though still overstating the degree of this solubility, does so to such an insignificant extent that the excess need not be taken into account for practical purposes.

I should state that in testing the solubility of calcic carbonate I use lithic carbonate for the precipitant, as the salts of lithia have far less solvent power over the calcic carbonate than those of soda have; with strontia carbonate the reverse seems to hold.

Operating in this manner I got results which assign the ratios by weight of the solubility of the earthy carbonates in water as follows:—

Calcic carbonate	1 part in 75,000 parts.
Strontia carbonate	1 „ 800,000 „
Baryta carbonate	1 „ 18,000 „

Calcic carbonate therefore appears to be soluble in water at a little under the rate of one grain per gallon instead of two, the lowest estimate heretofore assigned to it. The correctness of the rate of solubility of the strontia carbonate as given by Bineau is thus confirmed, while that of the baryta compound appears to be under one-fourth of that popularily assigned to it.

Art. LXIX.—*On the Presence of Nickel in the Auckland District.*
By J. A. Pond.

[*Read before the Auckland Institute, 23rd July, 1877.*]

In bringing this subject before the Institute, I have not done so with the intention of chronicling any valuable discovery, but simply to bring before the members the fact that we have the metal nickel existing in several parts of the province; nor can I lay claim to being the first to note the presence of this metal in New Zealand, as I find in the annual report on the Colonial Museum and Laboratory for 1876, Mr. Skey mentions its presence in troilite obtained in the geological survey of the Parenga River and Fox Glacier, Westland, by Mr. S. H. Cox.

My first acquaintance with the nickel of this province was on receipt of some stone from Mahurangi, about two years since, said to contain silver. This, however, was not present, but on further examination I found that the stone contained either nickel or cobalt, but the small amount at my disposal prevented my deciding in reference to these two metals. On receipt of a larger portion I succeeded in isolating nickel, but finding it in too small a quantity for commercial value, I did not pursue the matter further. A few months since I obtained some more stone of a similar character from the Kaipara, and found this to be a serpentine which also yielded nickel.

now made a careful research in all specimens to hand in which there were indications of this metal, and having made a quantitative examination, I herewith append it. The amount obtained is small, in no instance realizing one per cent., but the consciousness of its presence in the district will perhaps induce some of the settlers to more carefully note the mineral lodes in their neighbourhood, probably with the result of the discovery of larger quantities of the metal in question. The following are the localities where found, and the percentage in which it is present.

1. Loose stones obtained at Mahurangi, apparently of serpentine rock, and composed of silicate of magnesia, in which nickel is present in small and variable amounts.

2. Portions of a large rock-mass of serpentine outcropping in the direction of the Hotea from Mahurangi; in this I have found the largest amount of nickel, it being present to the extent of ·49 per cent.

3. Serpentine obtained from a small stream near the North Manukau, Head in which nickel realized ·47 per cent.

4. Calcite from Matakohe, stained in a peculiar manner with the hydrated silicate of nickel; the stone attached to the calcite is of the character mentioned in No. 1.

5. Hard greenstone from Papakura Valley, giving a trace of copper and nickel to the extent of ·26 per cent.

6. Green unctuous clay from Waipu of a very peculiar character. In this I anticipated a larger proportion of nickel, but was disappointed, it being present only to the amount of ·11 per cent. The colour of this clay is due, as in most of the other instances named, to protoxide of iron.

7. Foliated serpentine from Coromandel, in which there is a trace of nickel present.

The probability of this metal existing in larger quantities is, I think, very great, as but little time or attention has been devoted to the work of prospecting for other than the precious metals, and it is only through a careful examination of all minerals found that we can hope to have any success in the research. Respecting the probabilities of nickel being found in payable amounts, I would note that the deposits in New Caledonia of a silicate of this metal which have lately come into such notoriety are found in crevices in the serpentine rocks, and, as I have already remarked, my two largest results have been from serpentine; nor is it peculiar to this part of the world that it should be so situated, as Dana mentions several instances in which nickel is found in this rock. The efforts of a thorough research in the district between Mahurangi and Whangarei, through to the West Coast, may be well repaid should a body of stone containing a low percentage even be found, as in America ore containing only three per

cent. of nickel is mined with profit; while at Frieberg, in Saxony, even a much lower percentage is thought well worth the expense of recovery.

I cannot allow this short note to close without a few words upon a metal frequently accompanying nickel: I allude to cobalt. In the instances which I have already mentioned I did not find a trace of this metal, though I have succeeded in discovering it in this district in four distinct places in the shape of asbolite, the highest percentage yet found being 2·42 per cent., and this entirely free from nickel. I hope in the coming summer to still further investigate these deposits and bring the matter again before the Institute. With respect to the successful manipulation and refining of these minerals for commercial purposes in New Zealand, I am afraid very little can be done until we have sulphuric acid manufactured in the colony, as the importation of this article entirely excludes all chances of successful competition with the home refiners, and in consequence ores which might be utilized with profit must lie idly by awaiting the time when, from the cheap production of acid and its concomitant products, there may be a possibility of extending our manufactures and utilizing some of the raw material which the colony possesses.

Art. LXX.—*Notes on a Deposit in the Shaft of the Pumping Association.*

By G. Black.

[*Read before the Auckland Institute, 20th August,* 1877.]

I exhibit samples of the lime deposit which lately formed in the pumps and upon the timbers of the United Pumping Association shaft; the slab was broken off one of the timber frames in the shaft at a depth of 540 feet from the surface. I will briefly give a few details of its mode of occurrence.

This incrustation was first observed when the shaft was about 530 feet deep; in sinking at that depth a large body of quartz had been cut through, and when the strata upon which the quartz was lying was cut into, a great change took place; the water formerly was acidulous, it now became alkaline, and it was highly charged with carbonate of lime, which it held in solution and precipitated as it came in contact with the carbonic acid gas in the shaft. This deposit formed remarkably fast, and did not continue regular, some weeks it would form more in thickness than it did in others. The average thickness it formed on the buckets of the pumps was about a quarter of an inch in a week; it would coat a pick handle or drill in twelve hours, and this was a great source of annoyance to the men working in the bottom of the shaft, as the pick and hammer handles got coated with

the deposit and cut their hands, the skin being worn through, as they were actually working with tools encased in stone. At this time it also formed in the lines of the skin on the men's hands and arms, and took a great deal of cleaning and rubbing to get rid of.

It speedily began to act upon the working of the pumps, and castings had to be got specially constructed to disconnect the pump bucket from the rods below, as it would not come up the column, and as time went on the column had to be chipped the whole length inside to keep the water space clear; this was done by slinging five or six men at a time on to a rope and lowering them down into the column, which they chipped with chisel-pointed hammers. This operation would take about three days, but it wa not all performed at the same time, one part of the column would be done when we had to change a bucket, and another part was done at next changing of bucket, and so on, and by this means the lift was kept clear.

The twenty-five inch lift was cleared its entire length by this means three different times, and the working barrel at the ends of the stroke had to be chipped fortnightly.

The deposit was very irregular while forming, with regard to hardness. Sometimes it would form hard, sometimes soft; when it did form soft there was always more of it; sometimes it would form three-eighths of an inch in a week; when so, for two or three hours after the bucket came to the surface the incrustation was quite soft, but it hardened very soon on exposure to the atmosphere.

There is a peculiarity in the deposit, viz.,—it always forms in layers, and those layers change colour without any apparent cause—one layer may be white, the next one red, and it would keep changing in shade from pure white to a dark brown.

Where the water was hottest the deposit was most, and in some parts of the workings, on the thermometer being held in the stream as it issues from the rock, it will rise to 108° Fahr.; 100° is quite usual.

Since the crosscuts have been driven on both sides of the shaft the deposit has ceased forming in the pumps, and it now forms on the sides of the drives. The drives north and south for a distance of 800 feet on both sides of the shaft being now all coated with it, it also forms in the shoots in which the water is conveyed after it leaves the pumps on the surface. This deposit is not like what is formed below, being quite soft and having more of an earthy appearance.

There is an old shoot on the surface not now in use, along which a small quantity of water has been running; this shoot is about eight inches square inside and it has completely filled up with deposit during the last two months.

As may be readily imagined it was a great source of trouble and expense to keep the pumps at work while the incrustation was forming inside them, and now that it has ceased forming there, I hope we shall never have a repetition of it. I have sent this slab thinking it may find a place in the Museum.

NOTE.—Specimens of this incrustation were sent to the Colonial Laboratory in 1875, and reported on as follows:—

"No. 1753 is an incrustation taken from the cylinder of that large pump used at the Thames diggings for draining the lower levels of certain claims there adjoining the beach. It appeared to have incrusted a portion of this cylinder evenly over to a thickness of about one-quarter of an inch, and is very hard, also impervious to water, and presents to the naked eye an amorphous appearance, except on its inner side, this being, on the other hand, manifestly semi-crystalline; and besides is interspersed, though somewhat rarely, with crystals of iron pyrites. The pyrites is in all probability however, merely a mechanical deposit.

"The annexed results of an analysis made of a portion of this incrustation show it to be essentially carbonate of lime. As it has certainly been deposited in this form from some solution of it, and as the solvent for it in this case has most probably been water charged under a considerable pressure with carbonic acid it would appear that this incrustation has been induced by the escape of carbonic acid, caused by reducing the pressure and therefore the capacity of the water for carbonic acid by the action of the pump, resulting of course in a lowering of its solvent power for carbonate of lime:—

Analysis.

"Carbonate of lime	85·94
Carbonate of magnesia	·84
Iron oxides, with alumina	6·69
Siliceous matters, insoluble in weak acid	2·18
Soluble silica	·44
Water	2·17
Alkalies, sulphur, etc.	1·74
	100·00"

ED.

V.—GEOLOGY.

Art. LXXI.—*Remarks as to the Cause of the Warmer Climate which existed in high Northern Latitudes during former Geological Periods.*

By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 18th August, 1877.*]

Although nearly all modern geologists have been willing to admit that the phenomena of volcanos and earthquakes must be directly connected with the passage of heat from the interior to the surface of our globe, they have at the same time been indisposed to allow that this internal heat could have had any influence, even during the remotest geological times, upon the climatic conditions which affect the existence of life. Indeed, Sir Charles Lyell, who may be taken to have been the exponent of the views of the most advanced geologists of the day, more than once expressly denied the existence of any such influence, and sought otherwise to explain the remarkable fact that, within the arctic regions, where the present climatic conditions are almost opposed to the existence of terrestrial life at all, there occurred, in past geological times, a flora as rich as that which now occupies the hottest parts of the tropics.

It will, unquestionably, appear presumptuous in me to attempt to refute the opinions of Sir Charles Lyell and those who have followed him upon this point, but the recent investigations of physicists have led me to doubt whether those opinions are altogether tenable. Indeed, I think I shall be able to show that many of the facts mentioned by Sir Charles Lyell himself are only consistent with the proposition that the climatic conditions suitable to the maintenance of a luxuriant flora in arctic latitudes during early geological times were chiefly due to heat radiated from the interior of our globe.

In order that my line of argument may be understood I must, in the first place, call attention to the received opinions of all leading physicists as to the original condition of the material of our globe. Now, whatever doubts might formerly have been entertained as to the existence of nebulous matter, these doubts have been set at rest by the use of the spectrum analysis, and the beautiful theory propounded by Laplace in regard to the formation of our planetary system, has thus received a very strong confirmation. His theory is that the sun was at one time the centre of a nebula, whose diameter extended vastly beyond the orbit of the most distant of our planets,

and which revolved round its centre of gravity during the process of condensation. That, from time to time, extensive rings of this nebulous matter were left by the central condensing mass at points in the circumference where the centrifugal and gravitating forces became exactly balanced, and that these rings, still circulating round the central nucleus, broke up into masses which became endued with a motion of rotation and assumed a spheroidal form. These masses, acting in the same manner as the parent mass, and abandoning similar rings of outlying matter, led to the formation of the satellites of the various principal planets. During this process of condensation, which, of course, took place in obedience to the all-pervading law of gravitation, the motion of the condensing particles of which each planet was composed, was converted into heat, and that to such a degree as would result in the fusion of the whole into one mass. Meyer, indeed, remarks, in a paper on *Celestial Dynamics* (as quoted by Nasmyth and Carpenter in their great work on the moon), that "the Newtonian theory of gravitation, whilst it enables us to determine, from its present form, the earth's state of aggregation in ages past, at the same time points out to us a source of heat powerful enough to produce such a state of aggregation,—powerful enough to melt worlds; it teaches us to consider the molten state of a planet as the result of the mechanical union of cosmical masses, and to derive the radiation of the sun and the heat in the bowels of the earth from a common origin."

Sir Charles Lyell, however, though he did not dispute the opinions of Laplace and others as to the effect of the condensation of cosmical matter, appeared unwilling to admit the continued existence of internal heat to the extent contended for by leading physicists, and inclined rather to the opinion advanced by Poisson, "that in cooling by radiation to the medium which surrounded the earth, the parts which were first solidified sunk, and that by a double descending and ascending current the great inequality was lessened, which would have taken place in a solid body cooling from the surface." I am here quoting directly from Poisson, and not from Sir Charles' work, as I wish to show how completely at variance Poisson's opinions are with the laws which govern heated matter passing into the solid condition. Nasmyth and Carpenter point out, with special reference to the opinions of Poisson and of those who held similar views, "that fusible substances are (with a few exceptions) specifically heavier whilst in their molten condition than in the solidified state, or, in other words, that molten matter occupies less space, weight for weight, than the same matter after it has passed from the melted to the solid condition," and they point to the remarkable facts, amongst others, that cold iron floats upon molten iron, cold silver upon molten silver, cold slag upon molten

slag, and a variety of other cases of the same kind, in order to show how untenable are the propositions of Poisson and his followers, that if the globe had ever passed from a liquid to a solid state, in consequence of the loss of heat by radiation, the cooling and consolidation of the nucleus would have begun at the earth's centre.

Now, assuming that the views of Poisson are untenable, and that the cooling of the globe commenced at the surface, and extended towards the centre, it is palpable that the loss of heat resulting from radiation must have been greatest in the earlier periods of the earth's revolutions, and must have decreased in proportion as the solidified crust extended in depth. But, in our globe three different modes for the transmission of heat have been distinguished, the first being periodic and affecting the temperature of the crust according to the different positions of the sun and the seasons of the year; the second, also due to the sun, namely, that a portion of the heat of the sun which penetrates the crust in the equatorial regions moves through the crust towards the poles, where it escapes into the atmosphere; the third being derived from the secular cooling of the earth, and from the primitive heat still being disengaged from the surface. This latter has for many ages been very insignificant, owing chiefly to the fact that it is interrupted in its passage by an enormous thickness of sedimentary and other strata, which are very bad conductors of heat. Laplace has shown, by reference to astronomical observations taken in the time of Hipparchus, that within the last 2000 years no sensible contraction has taken place in the globe by cooling, but it must be borne in mind that such a period as 2000 years, vast as it may seem when taken in reference to ordinary historical events, is but as a fleeting second in the eras which have passed since our globe was condensed into its original fluid mass, and that it is therefore highly improbable that in so comparatively short a time any appreciable change in the length of a day arising from such a cause, could have been ascertained.

There is, however, a matter of very considerable importance in connection with the present distribution of heat in the crust of the globe, to which I must call your attention, namely, the periodic changes of temperature occasioned on the earth's surface by the sun's position and by meteorological processes. Now, it has been ascertained, by carefully conducted experiments, that these changes are continued in the crust of the earth, though to an inconsiderable depth, but that they are, nevertheless, such as even now to exercise a very marked influence on vegetation, and, indeed, on life generally. The slow conducting power of the ground, which checks the loss of heat in winter, is favourable to the growth of deep-rooted trees. "Points that lie at different depths on the same vertical line," says Humboldt, "attain the maximum and minimum of imparted temperature

at very different periods of time. The further they are removed from the surface the smaller is this difference between the extremes. In the latitude of our temperate zone (between 48° and 52°) the stratum of invariable temperature is at a depth of from 59 to 64 feet, and at half that depth the oscillations of the thermometer, from the influence of the seasons, scarcely amount to half a degree. In tropical climates this invariable stratum is only one foot below the surface, and this part has ingeniously been made use of by Boursingault to obtain a convenient, and, as he believes, certain determination of the mean temperature of the air of different places. The mean temperature of the air, at a fixed point, or at a group of contiguous points on the surface, is, to a certain degree, the fundamental element of the climate and agricultural relations of a district, but the mean temperature of the whole surface is very different from that of the globe itself." We have no data for determining the depth at which the stratum of invariable temperature lies within the arctic regions, but looking to the increase which takes place between that at which it is found within the tropics, and that at which it occurs some 20° further north, we may assume it to lie at a depth of little under 200 feet in the former region. I am not aware of the mean temperature of the air in the arctic regions, but it must be so low as to be absolutely antagonistic to all but the most stunted and hardy forms of vegetable life.

It must not be supposed, however, from what I have already said, that the supposed gradual diminution of the primitive heat of the globe has not been resorted to by geologists to account for alterations in climate. This is not the case, but, unfortunately for the earlier propounders of the theory, the condition of our knowledge did not afford them sufficient evidence in support of it, and, indeed, it is only within the last few years that the investigations of physicists have supplied grounds which would justify the proposition. The authority of Sir Charles Lyell, which was arrayed against it, tended moreover, to check further investigation, but although (as I before observed) I may be treated as presumptuous in endeavouring to set up this theory in opposition to his views, I feel that recent discoveries justify further discussion on the subject.

I now propose to consider briefly the nature of the surface conditions of our globe after the condensation of the nebular matter had been completed. We have in the present surface conditions of our own satellite, some evidence of what that of our globe would have been but for the presence of a controlling element, to which I shall hereafter allude. The researches of Nasmyth and Carpenter on the moon, published in 1874, have given to the world the clearest possible view of the present condition of her surface, indicating, as that condition does in the most unmistakable manner, its

origin as a mass of diffused cosmical matter, condensed into a planetary mass by the natural gravitation of its particles, such condensation resulting in the generation of heat sufficient to reduce the whole mass to a molten condition. But no sooner had this mass been completely formed, than it began to cool at the surface, by the radiation of its heat into space, and the surface must then have presented the peculiar aspect described by the authors referred to, as that exhibited by the surface of a pot of molten metal drawn from a melting furnace. But, as the process of cooling continued, a definite thickness of the surface would pass from the fluid into the solid condition, undergoing, whilst doing so, that expansion which is observed to take place immediately upon solidification, and causing, by such expansion, and the subsequent contraction which accompanies the cooling of a solid body, great irregularities upon the surface of that globe. During this first period the heat radiated would be sufficient to maintain, in a highly rarefied state, all the elements of our atmosphere, including aqueous vapour. But when this cooling had proceeded until the heat of the surface of the crust had been reduced to a point below the boiling point of water at the then rate of atmospheric pressure, the aqueous vapour would be condensed upon that surface in the form of water, which would gradually increase in quantity until the cooling had proceeded far enough to admit of the existence of life. We know that the divellent energies common to ordinary gaseous bodies, are even more conspicuous in bodies which assume the gaseous form at high temperatures. Thus water under the ordinary pressure of our atmosphere becomes thoroughly a gas only when heated to 212°, and retains this gaseous form, within certain limits, above its boiling point. But below 212° the case is different, the elastic force of aqueous vapour (as steam is more properly termed below 212°) rapidly diminishes, so that at 32° (the freezing point of water) its elastic force is found to be scarcely equal to one-fifth of an inch of mercury, and a given volume to weigh only $\frac{1}{150}$ of what steam ought to weigh, supposing water could exist as a perfectly gaseous body at 32° under a pressure of 30 inches of mercury. Hence the molecules of aqueous vapour at 32° must be five or six times further apart than in the perfectly gaseous form of steam, and so feeble in their repulsive force that, even when thus separated, the aqueous molecules cannot be approximated by slight increase of cold or of pressure without partial coalescence and the formation of water or ice. But we are told that the self-repulsive force exerted by the molecules of water in the liquid and even in the solid form, though feeble, is not annihilated, and that hence, when the atmosphere surrounding water or even ice is dry, the superficial molecules of the water or ice assume their self-repulsive character, and fly off until the surrounding atmosphere is saturated. The quantity of vapour which

can thus be held in solution in the atmosphere at any given temperature is fixed and invariable. But the quantity has not been found to be at any known temperature, and increases rapidly with increase of heat. Since, however, the quantity of water which the air can hold in solution at any temperature is fixed, it follows that when that temperature is reduced the superfluous water must be yielded up and deposited in the liquid form, such deposition, in the large scale of nature, usually constituting rain.

The question, however, naturally arises, whence has our globe derived its large supply of water? Now, this question has been fully considered by Mr. W. Mattieu Williams, in his admirable work "The Fuel of the Sun," and I make no apology to you for giving the substance of what he says on the subject almost in his own words. After pointing out his reasons for believing in the existence of an infinite atmosphere, of which the atmosphere surrounding our planet is but a denser portion, and after discussing the difference of atmospheric pressure at the surface of the various bodies constituting our solar system, he asks whether we are to consider the water which covers the lower valleys of the earth as planetary or atmospheric matter? Whether it is one of the special constituents of our globe or only a portion of the general atmospheric matter which the earth's gravitation has condensed round it? He then proceeds to discuss these questions by reference to those known properties of water, to which I have already alluded, which show that the position occupied by water on our own or any other planet is entirely dependent on comparatively moderate variations of temperature and pressure. "If," as he observes, "the temperature of the earth were raised or the pressure diminished in a sufficient degree, the whole of the water of the ocean would rise from its present bed and take its place in the atmosphere as one of its constituent gases, and would there exist in a state corresponding to the carbonic acid of our actual atmosphere." Indeed, after fully considering the matter, he comes to the conclusion,—a conclusion so fairly demonstrated as to be, in my opinion, irresistible, "that the water upon our earth is but a portion of the matter which its gravitation has collected from the all-pervading medium of the universe," and he adds that there is good reason to believe that gaseous water is one of the most important constituents of that general atmospheric medium, and probably constitutes a considerable percentage of the whole. He further observes that the spectrum analysis has afforded the strongest possible confirmatory evidence of an universal distribution of water, for that, whether directed to the sun, to the stars, to the nebulæ, or to the luminous matter of comets or meteors, the general reply is, "Water, water, water everywhere;" Professor Graham having even found occluded hydrogen in meteoric stones that have reached the earth, Mr. Williams

therefore says that "he will assume that water belongs to the atmosphere, and, in the present order of things, should be found as a constituent of the atmosphere of all the orbs of space; the state of its existence, whether solid, fluid, or gaseous, whether combined as water, or separated into its constituents of free hydrogen and free oxygen, being dependent on the physical conditions to which it is subjected."

Now, it is scarcely necessary for me to remark that all life, as it is known to us, is dependent upon the existence of water. This is a fact which we learn from any elementary work on physiology, and we are, therefore, justified in assuming that until water existed on our globe, at a temperature not inconsistent with life, no life could be developed upon it. You have before you on the table a series of specimens taken from the hot waters of springs in the Rotomahana district, showing, in all probability, the very highest temperatures compatible with the existence of living organisms, and we may look back to a period counted, probably, by hundreds of millions of years, when such low forms of life were the only ones which were to be found on the surface of our planet. And this brings me to the immediate subject of this paper, namely, had the heat radiated from the interior of our globe, any effect upon climate during the earlier periods of life brought under our notice by the geological records? I venture, for reasons which I will proceed to explain, to agree with the older ideas on the subject, in spite of the positive opinions expressed by Sir Charles Lyell.

It is clear that long before the surface conditions of our globe were such as to permit of the condensation of aqueous vapour upon it, it revolved round the sun in the orbit which it now occupies, and that even then the heat of its equatorial regions received a large increase from the latter body. It will have been observed that the depth to which the surface is now permanently heated by the rays of the sun diminishes with great rapidity as we approach the equatorial regions, but there is no reason for supposing that during the gradual cooling of the globe, the radiation of heat would, even supposing the absence of any check due to the sun's rays, have been greater from the equatorial regions than from the polar ones. The contrary must, in effect, have been the case, and the polar regions of our globe were doubtless the earliest to present surface conditions fitted to retain water upon them. If this were so, then certainly life must, in its earliest stages, have had its origin in arctic latitudes, gradually extending towards the tropics as the surface of the latter regions became sufficiently cool to permit water to accumulate there also. It will, of course, be understood that the accumulation of water on our globe was very slow, and I cannot but think that the arguments brought forward by Mr. Mattieu Williams, in the work alluded to, as to the materials which constitute the fuel of the sun, apply

to the presence of water on our planet. Our planet, in common with the sun and the other members of the system, is moving through space at the rate of four to five hundred thousand miles a day, and must, if the hypothesis of an universal atmosphere be correct, to the extent of its gravitation force, daily obtain from this universal atmosphere a fresh supply of water. Now this supply will be equal to that which can be obtained from the contents of a cylinder of this atmosphere, the length of which is from four to five hundred thousand miles by nearly eight thousand in diameter.

This is an interesting question, into which, however, it is unnecessary for me to enter, even if I possessed the elements necessary for the calculation of the probable quantity of water, if any, annually added to that upon our globe from this source.

Let me now enquire how far geological evidence can be adduced in support of the view that heat, radiated during the cooling of our globe, affected climate during the earlier periods of life upon it.

In dealing with this subject I propose to accept what has been given to us by Sir Charles Lyell in his great work already alluded to, in regard to the character of the life forms during past geological periods.

In the tenth and eleventh chapters of the tenth edition, published in 1867, the characters of the climate during the several periods extending from times immediately anterior to the historical, up to the Silurian period, is very fully discussed, and the author commences by commenting upon the objections which had been raised to the theory which endeavours to explain past geological changes by reference to causes now in action, pointing out that one of those objections is founded on the former prevalence of climates hotter than those now experienced in corresponding latitudes. I have before observed, however, that Sir Charles entirely repudiated the idea that during any portion of the time which has elapsed since life appeared on our globe, climate was affected by the heat radiated from the globe itself as the result of the cooling of its mass; and his whole argument is founded upon the assumption, that the changes which had evidently taken place were due to other causes than the one referred to.

I will not trouble you with references to times prior to the Pliocene period. With regard to that period, however, and more especially to its lower strata, in common with those of the Upper Miocene, we learn that the fauna and flora of the whole of Central Europe afford unmistakable evidence of a climate approaching that which is now only experienced in sub-tropical regions; and it is a matter of no small interest to know that when the climate of Europe was sub-tropical, a still greater heat prevailed nearer the equator, as specially evidenced by the investiga-

tions of Dr. Falconer, and Sir Proby Cautley, in the Sewalik Hills. Sir Charles remarks that these and other investigations lead irresistibly to the opinion that there was a much greater analogy in those ages than there is now between the temperature of the West Indies in latitude 18° and that of Europe in latitude 48°. But he also says, which is much more significant for the purposes of my contention, that if we pass from the equatorial to the arctic latitudes of the Northern Hemisphere, we find an assemblage of fossil plants resembling in many respects that of Œninghen, in Switzerland, in which Professor Heer detected the leaves, fruits, and sometimes flowers of about 500 species of plants, in which he found a near resemblance to the flora of the Carolinas and other southern states of the American Union. Of the Lower Miocene flora he says "that it has been traced from Italy northwards to Devonshire, and even to Iceland. In these high latitudes, however, the tropical and sub-tropical genera disappear, though the vine and tulip-tree and some other forms indicate a temperature 15° to 20° Fahr. warmer than that now belonging to the same countries," quoting Heer and Gaudin, "Climat du Pays Tertiare," pp. 174-207, in support of his statement.

Further on he says (still speaking of the Lower Miocene flora), "In Spitzbergen, in latitude 78° 56′ N., no less than ninety-five species of plants are described by Heer, many of them agreeing specifically with North Greenland fossils. In this flora we observe *Taxodium* of two species, a hazel, poplar, alder, beech, plane-tree, lime (*Tilia*), and a *Potamogeton*, which last indicates a fresh-water formation, accumulated on the spot. Such a vigorous growth of fossil trees, in a country within 12° of the pole, where there are now scarcely any shrubs except a dwarf willow and a few herbaceous and cryptogamous plants, most of the surface being covered with snow and ice, is truly remarkable."

With regard to the Eocene fauna and flora of Central Europe, we learn that it possesses species and genera having a great affinity to Lower Miocene forms, but departing further than these do from the modern European type, and resembling, in many respects, those of the tropical regions of India and Australia, and that, especially in the London clay of the Isle of Sheppey, fossil fruits of the cocoa-nut, screw-pine, and custard-apple remind us of the hottest parts of the globe. In the beginning of the eleventh chapter, Sir Charles specially calls his reader's attention to the fact, that an examination of the Pliocene, Miocene, and Eocene strata, viewed successively in the order of their higher antiquity, affords evidence of a temperature *continually increasing in proportion as we recede further from the glacial epoch.* (The italics are mine.) Passing now to the secondary formations generally, the same law as that traced in the tertiaries is found

to obtain, the peculiar reptilian fauna which characterizes this period indicating unmistakably the existence of a warm temperature in the seas, lakes, and rivers, whilst the flora supports the hypotheses of Heer, Adolphe Brogniart, and others, that the climate of Europe, even within 12¼° at the Pole, must have resembled that of the West Indies at the present day.

I might repeat the same language with regard to the Triassic, Jurassic, Carboniferous, Devonian and Silurian periods, all of which afford similar evidence, but I prefer quoting the following general remarks on the subject, with which Sir Charles Lyell concludes the eleventh chapter of his work:— "The result, then, of our examination in this and the preceding chapter, of the organic and inorganic evidence relating to the climate of successive geological periods, is in favour of the opinion that a warmer temperature generally prevailed in the northern hemisphere from the 30th parallel of latitude to the pole than that now experienced. In the Pliocene era the fauna and flora of Central Europe were sub-tropical, and a vegetation resembling that now found in Northern Europe extended into the arctic regions as far as they have been yet explored, and probably reached the pole itself. In the secondary or Mesozoic ages, the predominance of reptile life, and the general character of the fossil types of the great class of vertebrata, indicate a warm climate and an absence of frost between the 40th parallel of latitude and the pole, a large *Ichthyosaurus* having been found in latitude 17° 16′, and the general character of the Mollusca and corals, as well as of the plants, being in perfect accordance with the inferences deduced from the fossil reptiles. If we carry back our retrospect to the primary or Paleozoic ages, we find an assemblage of plants that imply that a warm, humid, and equable climate extended in the Carboniferous period uninterruptedly from the 30th parallel of latitude to within a few degrees of the pole, or to northern regions where at present the severe winter's frost and the almost universal covering of snow, lasting for many months, preclude the existence of a luxuriant vegetation. In rocks older than the Carboniferous the evidence of plants, insects, and fish fails us; but the invertebrate fauna has such a resemblance to that of the latter primary and the older secondary periods as to force us to believe that the climate of the temperate and arctic regions was very analogous to that which generally prevailed in these subsequent epochs."

As before observed, however, Sir Charles, and those who follow him, decline to admit that heat radiated from the surface of our globe during its secular cooling from an original heated condition, had any influence in producing these observed differences in climate in the northern regions, and attribute them entirely to successive changes in the distribution of land

and water. It is certainly true that the Gulf Stream at present exercises a considerable influence on the climate of the localities on which it impinges, but this influence does not produce, outside of tropical regions, such effects as those which would be necessary in order to account for the existence in arctic regions of plant forms of the classes above alluded to; and it is scarcely possible to conceive any distribution of land and water which could result in such effects, in the past, upon the climate of a part of the globe, the present climatal conditions of which are admittedly almost opposed to the existence of any vegetation whatsoever. But if we find that the polar regions were those which were first fitted for the retention of water, we may fairly assume that it is in those regions that we must search for the first indications of life on our globe, the temperature of those portions which lie between the tropics, and for several degrees on each side of them, being necessarily maintained for a much longer period at a heat too great to permit water to lie upon the surface. It is curious in this connection to observe that Sir Charles has given us maps (now shown to involve serious fallacies) showing the relative distribution of land and water which would be calculated to produce, in the present day, at all events, the maximum of heat and cold on the surface of the globe, that which applies to the former showing the bulk of land lying for about 45° on each side of the equator, and that which applies to the latter showing the bulk of the land extending for a similar distance from each of the poles. On the whole, therefore, I feel that there is some justification for believing that the climate of the arctic and antarctic regions of our globe during the past geological epochs to which I have referred, was directly influenced by heat radiated from it during its secular cooling from the condition of a molten mass of aggregated cosmical matter, and that the first appearance of life took place when portions of its surface became sufficiently cool to admit of water resting upon it at a temperature not exceeding 120° Fahr.

I do not apologize for bringing these views under your notice, as I agree with Mr. Mattieu Williams that it is fortunate for the human race that men who study pure science are so far raised by its moral influence above prejudice and personality, that their perception of truth is not obscured by the medium through which it is conveyed, and that it is accepted as frankly, fairly, and courteously from the humblest outside student as though presented by the highest constituted authorities. If the views contained in this paper have no soundness in them they will be calmly refuted, or suffer death from deserved neglect. If, on the other hand, they are at all sound or suggestive, they will receive acceptance even from those whose preconceptions may have been opposed to them.

Art. LXXII.—*Further Remarks as to the Cause of the Warmer Climate which existed in high Northern Latitudes during former Geological Epochs.* By W. T. L. Travers, M.H.R., F.L.S.

[Read before the Wellington Philosophical Society, 17th November, 1877.]

It will be remembered that I had the honour of reading a paper before this Society in August last, in which I ventured to urge that the warmer climate which unquestionably prevailed in high northern latitudes during former geological periods, as evidenced by the character of their fauna and flora, was chiefly due to the radiation of heat conducted from the interior to the surface of our globe. Since then I have had an opportunity of studying Mr. Croll's great work on "Climate and Time," in which that gentleman expresses his dissent from all such theories, and endeavours to show that the better climatal conditions in question were indirectly due to changes in the eccentricity of the earth's orbit, resulting in alternations of cold and warm periods at irregular intervals, brought about through the medium of heated ocean currents impelled towards high latitudes under the operation of the trade winds. To those who have had the advantage of studying Mr. Croll's work, it will, undoubtedly, appear presumptuous on my part to dispute the conclusions he has arrived at, and still more so to maintain a proposition at variance with his opinions, but I venture to think that in his treatment of the question he has overlooked some points of great importance with which I propose to deal in this paper. But before alluding to those points let me call your attention briefly to the views which Mr. Croll propounds.

In the first place he calls attention to the changes which constantly take place in the eccentricity of the earth's orbit, and points out that when this eccentricity is at its superior limit (=·0721) the difference in the distance of the earth from the sun when in the aphelion, as compared with the perihelion of its orbit, is upwards of 14,000,000 of miles, and that the amount of heat received by the earth when in those two positions will be as 19 to 26. He next points out that if, according to the precession of the equinoxes, winter should happen in the northern hemisphere when the earth was in the aphelion of its orbit, at the time when the orbit was at its greatest eccentricity the difference in the amount of direct heat received from the sun would be sufficient to bring about a recurrence of the glacial epoch. On the other hand he urges that if, under the same circumstances, winter were to occur in the northern hemisphere when the earth was in the perihelion of its orbit, the difference between winter and summer in the latitude of England, at all events, would be almost annihilated, whilst extreme glacial conditions would be transferred to southern latitudes.

He further alleges, that in the latter case the effect of the trade winds would be to impel the heated currents of the Atlantic and Pacific Oceans further towards the North Pole, thereby causing the ice within the arctic regions to disappear, and so producing a climate sufficiently mild to admit of the existence in those regions of a fauna and flora as rich and varied as that which characterized them during any past geological period.

In the nineteenth chapter of his work he gives a diagram showing the eccentricity of the earth's orbit for 3,000,000 of years in the past, and 1,000,000 of years to come, at periods of 50,000 years apart, and tables showing those matters more in detail at intervals of 10,000 years. On looking over the diagram it will be seen that there were three principal periods in the past during which the eccentricity rose to a high value. It is to one or other of the last two that Mr. Croll assigns the geological period familiarly known as the glacial epoch, preferring, however, the later to the earlier one for reasons into which he enters at some length.

The later period consisted of two separate maxima, the earlier one being the greater of the two, and separated from the latter extreme by an interval during which the eccentricity was considerably diminished although still comparatively high, the whole period occupying 160,000 years, one-half of which would represent the united length of the cold phases in each hemisphere. Now, assuming Mr. Croll's views to be correct, the glacial epoch which was brought about by this condition of things would continuously affect each hemisphere alternately for a period of about 10,500 years, owing to the *precession of the equinoxes.* But the operation must have been complicated by the circumstance that, during the 160,000 years in question, there was a period of lesser eccentricity occupying some 30,000 years, during which the intensity of the cold would have been diminished in each hemisphere. It will be observed therefore that, during the period referred to, the conditions requisite, according to Mr. Croll's theory, for the production and removal of glacial conditions in the northern hemisphere would have occurred with varying intensity at alternating intervals of 10,500 years about four times, owing to the precession of the equinoxes, or, in other words, that the arctic circle would, at the intervals referred to, alternately have enjoyed atmospheric conditions which would admit of the existence of a luxuriant fauna and flora, or such as were utterly opposed to the existence of any terrestrial life.

But a glance at Mr. Croll's diagram will, I think, sufficiently show that, whilst his theory may abundantly account for an extension of pre-existing glaciated conditions in each hemisphere during periods of maximum eccentricity, there is nothing in it to lead to the conclusion that the polar ice has ever been completely removed since its first formation in mass, which, as I

contend, could only have commenced when the temperature of the surface of the ground within those regions had fallen permanently below 32° Fahr. Since my former paper was read before this society, the May number of the "Quarterly Journal of the Geological Society" has been received, and I find that the same subject which was dealt with by me in my former paper had been referred to by Professor Duncan, President of the Society, in his anniversary address. He points out that in the science of geology "strict uniformitarianism is giving way to a school which insists upon the recognition of a scientific cosmogony, which attempts the study of the mutations of the globe from the beginning, from the example of stellar and solar changes, and which considers that the principal factors in terrestrial alterations (the solar heat and the residual heat of the earth) are energies undergoing only a definite amount of reversible and more or less irreversible transformation." And he adds that it follows, as a result of the investigations of this school, that "in the earlier geological ages, the extent and rapidity of the successive changes were greater than in the modern example, that the rigidity of the globe was less, that the internal heat and its expression in temperature at the surface were greater, and that the meteorology was such that the wear and tear of world-wide nature was larger in its annual amount." Further on, in the same address, the learned Professor remarks, "that it must be acknowledged that a permanent increase of a few degrees of the temperature of the waters would kill off many species, and that the whole flora and fauna would cease to exist were the average heat double what it now is; that the same result would follow a moderate increase of the heat of the soil with regard to the plants; and that if the estimated amount of the heat radiated year by year, after conduction from within, relates entirely or mainly to a former much greater annual average, all being residual in its nature, the question of the possible lapse of time since the surface was cool enough to permit of life arises, and has been ably used in argument against absolute uniformitarianism."

I ought not to make these quotations, however, without adding, that Professor Duncan does not go deeply into the question in the aspect presented in my own paper, nor can I cite his address as being altogether in support of my views; but it was satisfactory to me to find that such a speculation as that in which I ventured to indulge, was not altogether without interest or foundation in connection with geology as a practical science. My own views, put in concrete form, are these: That the arctic and antarctic regions were those which first presented climatal conditions suited to the existence of life, inasmuch as those regions must have been the first to cool down sufficiently to admit of water resting upon them in a permanently liquid condition. That, as a consequence naturally following

from the above proposition, the polar areas have become, in process of time, the great refrigerators which have supplied the cold waters now occupying the deeper parts of our oceans. That a warm climate was maintained in the polar regions—long after the heat conducted to the surface from the interior of the globe had ceased to maintain the waters above 32° —by currents of the warm water which occupied the central parts of the earth's surface; but that, so soon as the surface of the land within the polar areas had cooled sufficiently to enable snow to rest and accumulate upon the surface of the ground during ordinary winters, cold began to gain upon heat, and permit the formation and gradual accumulation of permanent ice. That ice once so formed in mass has never since been entirely removed from extreme northern and southern latitudes, but has probably extended from each towards the equator, under the operation of causes upon which I offered no opinion, but which probably were those so fully discussed by Mr. Croll. To this extent I agree with Mr. Croll, but I think he has overlooked, in connection with former climatal conditions in high latitudes, the enormous period of time which must have elapsed since the great body of water which now occupies the surface of our globe had accumulated upon it, and the effects which, during long ages, must have been produced by the passage into high latitudes of currents of water still owing its warmth to heat conducted to the surface from the interior of our globe, under the very impulses which he himself has shown to exist. It follows, moreover, that independently of the occasional extension of glacial conditions into lower latitudes, as suggested by Mr. Croll, there is reason to suppose that the climate of those latitudes will continue to suffer a gradual degradation in temperature, owing to the continuing refrigeration of the waters of the ocean, unless, indeed, this has already reached a mean, and that in the distant future the northern portions of the temperate regions may become uninhabitable, except by races like the Laplanders or the Esquimaux. Mr. Croll objects that the quantity of heat conducted from the interior to the surface of the globe is now utterly insignificant as an agent in modifying or affecting climate, but that it is still considerable cannot be doubted. The following passage from Mr. Poulett Scrope's work on Volcanos is in point on this matter:—

"In support of the hypothesis advanced at the close of the last chapter, we have, in the first place, the well-known evidence of mines and artesian wells to the fact that the temperature of the crust of the globe increases everywhere in a very rapid ratio from the surface downwards, varying from one degree in 50 to one degree in 108 feet of vertical depth, and consequently that a large amount of heat is continually in course of outward transmission from within this envelope

through the superficial rocks, and the waters that permeate or cover them, into surrounding space. Secondly, we have the phenomena of volcanos, proving, as has been shown, that, besides this, another considerable amount of heat is continually effecting its outward escape—with less regularity, but with equal constancy—by the exhaustion from within of heated vapours and thermal waters, and the eruption of incandescent lavas. The continuance of these phenomena, through every past age of the globe, proves the accession of continual increments of caloric from great depths within its interior to the mass of lava, or the material from which lava is elaborated, that underlies the outer hardened and comparatively cool crust;" and he further remarks,—"That it would seem that the outward transmission of internal heat by these two combined modes is insufficient for its discharge as rapidly as it is supplied from within, inasmuch as a third collateral order of phenomena, the plutonic, attests the frequent expansion only to be accounted for by increased temperature of extensive underlying masses of matter."

I may, moreover, in conclusion, cite the following passage from Professor Duncan's address, as possessing interest in connection with my papers. After remarking that we may readily believe in a universal atmosphere whose tenuity is greatest between the great attracting bodies, and referring to Mr. Mattieu Williams' views on this subject, he says,—"Reasoning, then, by analogy, the earth should have had a higher atmosphere, and probably more of it in the past, and this would be very compensatory. A slightly greater atmospheric pressure would counteract the greater possible rate of evaporation; and this compensation rather adds to the probability of the theory. With more aqueous vapour and a more energetic sun, sub-aerial denudation may have progressed far above its present average rate. Moreover, the greater movable atmosphere would absorb much of the heat of the hotter sun, and would modify its action on the surface; and, on the other hand, a greater diffusion of equable temperature would prevail, *and towards the poles there would be prolonged twilight.* A greater rainfall and more rapid movement of the lower zones of the atmosphere would result; and as the supply of moisture must have been greater, there is no reason why the local glacialization of high mountain ranges should not have occurred. *The improbability of the occurrence of masses of ice on the sea-level, or for some thousands of feet above it or at the poles, must, however, be admitted.*" The italics are mine in the foregoing quotation, and the passages so marked bear, as will be seen, a good deal upon my views.

ART. LXXIII.—On the Formation of detached Shingle Beaches.

By JOHN CARRUTHERS, M. Inst. C.E.

[Read before the Wellington Philosophical Society, 17th November, 1877.]

THE travel of sand and shingle along a sea coast is not due to any currents which may obtain, but to the breaking of the waves on the beach. There is very seldom a littoral current strong enough to carry shingle or sand along with it, but where even a small wave breaks it has sufficient impetus to move shingle.

If the wave breaks square to the coast the shingle is thrown directly forward; when the wave recedes it carries the shingle back with it to the place it started from. In this case there is no travel of the shingle; it is thrown ashore and pulled back by the waves, time after time, over the same course until it is ground down into sand or mud. If, however, the waves break obliquely on the shore, the shingle is carried forward by the wave, but when the latter recedes it does not travel on the same track by which it rolled forward, but takes the line of quickest descent, which is at right angles to the beach. The shingle thus travels in a zig-zag path moving gradually along the shore in the direction of the waves. This causes a travelling beach.

The travelling shingle will often refuse to follow a sudden indentation of the coast and goes straight across the bay, forming a detached beach with a lagoon behind it. This may, I think, be explained in this way: Waves travel less quickly in shallow water than in deep; the inner end of a long oblique wave being in shallower water than the outer end is, therefore, checked as it approaches the shore and the wave takes a curved form. At the point forming the beginning of the bay this action is of course intensified, and the waves roll round the point in long curves which tend more and more to become perpendicular to the coast line. The varying speed of the waves, due to the varying depths and the different distances they have to travel, destroys the uniformity which obtained along the straight part of the coast; the waves cease to be continuous billows; those rolling on the outside of the point strike those breaking on the inside on the flank, and are tripped up and broken exactly as they would have been on a solid shore. The shingle is then deposited, and a spit is formed stretching out into the bay. When the spit reaches deep water the process becomes more simple; the waves rolling into the bay beyond the spit being in deep water do not break, but those striking the spit are broken and carry on the shingle exactly as was done on the straight coast line. In this manner the spit stretches at last quite across the bay, and becomes daily

higher and wider as more shingle is thrown up it and over it by the waves.

An island lying off the coast on which there is a travelling beach also causes the latter to detach itself from the shore. The island forms a breakwater, and the shingle cannot pass across the still water behind it. It therefore collects on the windward side until it reaches out to the island, from the leeward side of which it continues its course as a detached beach.

Strong littoral currents and rivers entering the sea cause the waves to break before they reach the shore. If there is any travelling shingle it will be collected where the waves break, and will therefore form a detached beach.

In short, given a source of supply of shingle or sand, such as a large river or a cliff against which the sea beats, there will be a travelling beach wherever the average direction of the waves is oblique to the shore on which they break, and there will be a detached beach whenever, from any cause, the waves, under similar conditions, break before they reach the shore. The principal causes of this latter case are those above enumerated.

There are in New Zealand many examples of detached beaches. The spit of sand which ends Cape Farewell is an example on a very large scale.

The source of supply is in this case the whole west coast of the South Island with its many rivers. The débris formed by the denudation of the land is driven northwards by the prevailing south-westerly seas which break obliquely on the shore. At Cape Farewell the breaking of the waves against one another instead of on the shore caused the sand to be thrown down before reaching the shore on the east side of the Cape. The spit began to form and is still forming. Eventually, Golden Bay will become a lagoon if a sufficient supply of sand is kept up by the continued denudation of the west slope of the island.

Nelson Harbour is another case of a detached beach. The cliffs to the north of the harbour are being cut down by the sea, and the material, driven by the oblique north-westerly seas, which are here the most powerful, crosses the indentation of the coast on which Nelson is situated; the earthy matter contained in the cliff is washed away leaving only the mass of heavy boulders, which are all of the same material as those embedded in the cliff from which the boulder bank is derived.

Lake Ellesmere is another fine example. The coast of Canterbury consists of a travelling shingle beach on a scale of magnitude hardly equalled in the world. The great Canterbury rivers are nothing but mountain torrents on a magnified scale. They have their rise in ranges formed of clay-slates of a very friable nature, and they convey to the sea great quantities of shingle.

The oblique south-easterly seas drive this shingle to the northward, spreading it along the Ninety-mile Beach.

The direct cause of the detached beach at Ellesmere is the Rakaia River, the delta of which forms a projecting point from which the Ellesmere beach starts on its detached course. Similar beaches have, no doubt, been formed at different times near the mouths of all the great rivers of Canterbury, forming lagoons which have been gradually filled up by material brought down from the mountains by the rivers, as Lake Ellesmere is now being filled up.

ART. LXXIV.—*On Gold in the Wellington Provincial District.*

By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, 21st July*, 1878.]

THERE are certain veins of quartz to be found in the rocks of the Tararua and Rimutaka, that is to say of the mountains extending from Cook Strait to the Manawatu, which are of a peculiar character, and I have always had an idea that, if we were to find minerals hereabouts, these were our true veinstones.

The results of analyses did not prove satisfactory, and I have allowed the matter to sleep for a number of years. About two months ago, however, I took a specimen of this quartz which had been lying on my mantel-piece for some years, and sent it to a friend in Melbourne to see what they would say to it in that city. I have received a reply, with analysis by Mr. Chapman, who is described as being "mineralogist and assayer to the Bank of Victoria, and is deemed the best in the colony." It is as follows :—

"Bank of Victoria, Melbourne, 23rd May, 1877.

"I have tested the quartz specimen left with me for assay, and find it to be composed of sulphate of iron. I likewise assayed for gold, and from 1,000 grains got a button weighing ·034, or 1·092 ounces per ton,

J. CHAPMAN."

The result seems highly satisfactory, and may lead to the opening of numerous valuable mines, not only in this neighbourhood, but all about the ranges as far as the Bay of Plenty, also in the Kaimanawa Range, and I think I may say in the eastern ranges of the South Island. Of course we must not jump to the conclusion that because one specimen from one locality has proved to be auriferous, we shall find the same result in other localities, but there is strong reason to hope and to suppose that this may be the case.

The character of these veinstones is very similar, both in appearance and in mode of occurrence, wherever they are found, except that in some places the vein is only a few feet wide, whereas in others it may be thirty or forty feet thick. If we find a similar result to that already obtained from several different localities, we may then, I think, conclude that we have valuable mines in the district.. I know a great many places in which these veinstones are found, and will now proceed to describe them.

These reefs appear to me to be found chiefly along two lines, and run in the direction of the ranges—viz., about N.N.E. and S.S.W. The western line intersects the upper part of the Otaki River, and that of the Hakatarewaha, and probably appears in a confused and undefined state at Baker's Hill, near Wellington.

The eastern line appears to strike up the valley of the Orongorongo, in which locality the specimen under discussion was found. There is a reef of this stone on Sinclair's ground in the upper part of the Wainuiomata, and there are indications of it about Drake's Elbow on the Rimutaka road, all pointing to the general direction of this line.

The widest reef which I have seen is situated on the banks of the Waiotauheru, a branch of the Otaki River. It is a long time since I have seen it, and therefore do not like to speak positively as to the dimensions, but I think I should be safe in calling it at least a chain wide.

In the upper part of the Hakatarewaha I found a reef about four feet wide.

On the western line I think that attention should first be directed to the valleys of the rivers above named, particularly as there is now easy access to the valley of the latter river.

To reach the reefs of the Otaki River cannot be an easy matter at this time of year. It is difficult to give an exact idea of the distance to be travelled, but an estimate may be formed from the length of time it took me to reach them. From the Wairarapa pa, near the point where the Otaki River leaves the mountains, it took me a day and a half walking to reach the reefs. In returning down stream it was an easy day's journey to reach Otaki itself.

When the base of the higher part of the ranges is reached, the Otaki River is found to fork. The main stream comes down from the northward, and a large tributary called the Waiotauheru falls in from the southward. About two hours' journey up the latter river I pitched my camp, and near it were the reefs in question, cropping out on the right bank of the river, and standing vertical.

The character of these reefs is typical of all the others of the same kind. The quartz stands in lines of three or four inches thick, separated by mullock. The quartz veins have an undulating conformation, chain-like, so

that lumps may often be broken off at the thinner parts, and appear in a boulder-like form. The quantity of mullock separating the layers of quartz ought, I suppose, to make the working of these reefs very easy.

Supposing the Otaki reefs to be gold-bearing the question of access would be a serious consideration. There would not, I think, be any particular engineering difficulties in forming a road to them from Otaki, but it would be a work of considerable outlay. I think it probable that a low saddle might be found by which to reach them from the valley of the Hakatarewaha.

I have not examined the valley of the Ohau, the next river to the northward of the Otaki, but prospectors found a good deal of gold in the terraces of that river, although not enough to pay.

The Otaki reefs ought of course to be traced if possible to the Ohau, and it seems to me that the gold found in the terraces is strong corroborative evidence of the auriferous character of the reefs, and also that the particular reefs about which I write are the true mineral lodes of the district.

I wish it particularly to be borne in mind that I found no signs of mineral veins in ascending the Otaki River until I reached the reefs in question on the Waiotauheru.

Now that the Hakatarewaha is opened by a road, it would be comparatively easy to prospect that valley; and I am inclined to think that if the line of strike of the Otaki reefs were first obtained, and then followed into the Hakatarewaha, reefs in that valley would be soon picked up, if not obvious without adopting this plan.

These reefs are naturally most easily found in sections of river banks, and this mode of discovering them is the best in the upper parts of the rivers. When, however, the rivers have spread out into valleys, and have formed large deposits of alluvium or of shingle, then they prove of little or no assistance.

It would be advisable to examine the upper part of the Hutt River, and of its tributaries, to ascertain whether or not any reefs crop out there.

With regard to what I call the eastern line of reefs I cannot speak so positively. I have found the stone about Orongorongo, and I am told that it is found all the way up that valley. As I have said above, I have seen it in the Wainuiomata, and indications of it about Drake's Elbow. Indications may also be found along the road between the Pakuratahi and the Rimutaka saddle. The whole line requires further prospecting.

I would by no means discourage further search in the direction of Makara. A considerable quantity of gold has been found there, but the reef has not yet been struck. If, however, the particular kind of quartz which I point out be carefully looked for, and if found in veins then followed up, we may perhaps arrive at a satisfactory result after all.

There is every reason to suppose that this quartz may be found in the Ruahine and all through the mountains as far as the Bay of Plenty. I have seen specimens of it from the Kaimanawa Range. I would suggest that it should be looked for well within the ranges, and not only on the outskirts or flanks. These, from being more easily accessible, are no doubt first examined.

The same remark will apply to the eastern ranges of the South Island. I think I have seen indications of this quartz some distance up from the Hurunui Gorge, but it was a long time ago, and I cannot speak with certainty. As the rocks of the eastern ranges of the South Island are of similar character to those of this district, there is, *primâ facie*, good reason for investigation.

My impression is that this quartz will in no place be found rich in gold, and, therefore, that the mines, if any, will not be subject to great fluctuations in value, but that the stone, if payable, will make up in quantity for what it lacks in quality. It is a quartz of such a peculiar character, with its mullocky casing, that a miner once acquainted with it, would be sure to recognize a vein of it at the first glance.

The reef of the Otaki River is by no means made up of a mass of solid quartz. The mullock occupies perhaps as much space as the quartz, and there are also slaty partings.

The reefs ought also to be looked for up the valleys of the Wairarapa rivers, and far up these valleys. The beds of these rivers will be hardly accessible at this time of the year, and some months may have to pass before they can be searched. The localities are also very inaccessible, supposing auriferous quartz to be found there, but the plan should be to find the quartz first, and then to contrive how to take a road to it. By the Wairarapa rivers I mean those chiefly from the Tauherenikau to the Ruamahunga inclusive. The Cape Palliser ranges should also be examined.

There is one defect in the composition of the stone which may be serious and possibly fatal to its payable qualifications. The gold seems to be associated with sulphate of iron, which will make it difficult and expensive to extract. I believe that great improvements have been effected in Victoria and elsewhere in the economical reduction of similar ores, and hope that this defect may not prove an insurmountable obstacle.

Art. LXXV.—*On the Occurrence of Gold in the Mackenzie Country, Canterbury.* By Alexander McKay, of the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 4th August*, 1877.]

It is noteworthy that above a certain point no workable deposits of alluvial gold have hitherto been discovered in the valley of the Waitaki River, or in any of the several rivers which, making junction near the south-eastern corner of the Mackenzie Country, are thence in their further course known as the Waitaki River.

If the abundance of quartz in a river bed be an indication of its auriferous character, some of the western tributaries of the Waitaki should long ere now have been famed for their rich deposits of gold, but as yet the finds have been few and of little value. Not that the district has been neglected by prospectors, for, ever since the Lindis rush, gold in the Mackenzie Country has been the dream of many a miner on the Otago goldfields; and scarcely a year passes without another attempt being made to discover payable gold in this district.

Further, on the breaking out of the West Coast goldfields a constant stream of miners from the inland districts of Otago reached the Canterbury Plains, and so the West Coast by the shortest, but also the most difficult route, leading through the Mackenzie Country. It was thus to be expected that in a country where one class of indications were eminently favourable a considerable amount of prospecting should be carried on.

The Coast was, however, too powerful a magnet to be counteracted by the simple chances of finding gold in a district where possibility was the only inducement held out, and consequently we find that disappointed diggers returning from the West Coast were those who first applied themselves to the prospecting of the Mackenzie Country.

These, badly equipped for such an undertaking, and generally without sufficient means, naturally could not devote much time to the work, and therefore could not, under the circumstances, bring their labours to a satisfactory conclusion.

This resulted in their again seeking the goldfields of Otago, where the favourable accounts carried by them induced others better prepared for the work to join them, and so, in the favourable season, prospecting parties made their way along most of the rivers and large creeks in the western part of the district.

The severity of the winter months generally compelled the return of these expeditions with no other results than a confirmed belief in the auriferous character of the district; the amount of gold obtained being generally very small. But though the same party seldom returned, next

year was sure to bring several others across the Lindis Pass, one or other of which was certain to reach as far east as the Ben Ohou Range, to the west of Lake Pukaki, where the changing character of the river deposits generally arrested them. It will thus be seen that, in the face of continued non-success, prospecting was most persistently indulged in by numerous independent parties, none of which, although circumstances may have prevented their return, ever left without intending to return.

The mere fact that there is much made ground (consisting of glacier moraines, lake and river terraces) in the district, that the river beds abound with quartz, or that gold in small quantities has been found, do not fully account for the universal belief that paying deposits of alluvial gold will be found. And, but for the existence amongst miners of a theory upon this subject, prospecting would probably have been discontinued in a few years after the opening of the West Coast Goldfields.

The theory alluded to is, that as the Mackenzie Country lies to the west of a line drawn from the central part of the Otago Goldfields to Hokitika or Greymouth, the Mackenzie Country being to the west of this line, and therefore lying directly between the Otago and Westland Goldfields, must (the indications being favourable) be auriferous also; and this belief alone kept many in the field who would otherwise have left before they did.

The above facts alone considered, the probable truth of the theory must be conceded, apart from the actual occurrence of gold in the district. But if a map showing the geological structure of the district be examined, the error to which the theory leads will be at once apparent, although there are important facts connected with this subject, the details of which do not appear on any geological map which I have seen.

The boundary between the auriferous schists of Otago and Westland does, indeed, follow the water-shed of the Waitaki Valley, as shown by Dr. Hector in his Geological Map of New Zealand, 1873; and, in a general sense, no auriferous rocks have been shown to exist east of the main water-shed in the provincial district of Canterbury, the non-auriferous character of the rocks at once accounting for the general scarcity of gold in the alluviums of the district. But from the plan and section which I show, it will be seen how much auriferous material may be brought down the rivers with but an insignificant exposure at the surface of the rocks whence the said materials are derived.

The summit of Mount Cook and its eastern slopes consist of slates and sandstones which have not yet been proved auriferous, while to a considerable altitude on its western slopes auriferous rocks are found. This same arrangement with some modification extends throughout the first forty miles of the southern continuation of the main range, the non-auriferous

rocks reaching, at high levels, to the axil line of the range, but the numerous streams flowing west and south from thence in valleys and mountain gorges of great depth have in many cases removed the higher rocks, and now bring down the waste of the underlying auriferous schists, which, in the case of the Ahuriri River, is carried to its junction with the Waitaki, there being no lake, as in the other cases, to intercept it, or if there ever has been, it has long since been filled up.

Thus there is a marked difference between the shingle now filling the river beds and that derived from the same geographical position before the higher rocks had been removed; morainic accumulations, both lateral and terminal, being remarkably deficient in auriferous material, as are the rivers below the outfall of the lakes.

It will thus be seen that the localities likely to yield gold in any quantity are those rivers and creeks the sources of which cut deep into the auriferous rocks, but this being the case it is often very difficult to find gold even then, as the sources of the rivers are often nothing more than a tremendous aggregation of fallen rocks, many of them exceeding the contents of this room. There is scarcely an intermediate condition between this state of things and an open river bed, in which a hole cannot be sunk more than a few feet without finding that the bottom cannot be reached on account of water.

Though gold is to be found in many creeks which do not expose the schistose rocks, and from one of these the gold now shown was obtained, as a rule it is otherwise. Its mode of occurrence was very peculiar, and deserves some notice here. It comes from the first creek above Lake Ohou, coming from the west, but gold in quantities more than a mere colour is confined to about a mile of its course only. It is not surprising that it should disappear in the flat shingle beds near the lake, but its remarkable disappearance above a certain point as the creek is followed up remains to be explained, as there are one or two small flats and terraces which are quite as likely as those in which the gold is found.

There are two explanations of this. One is that the gold is derived from the destruction of an old lake terrace, cut through by the creek. But as this is not a solitary example of such action, why, I ask, is there no gold at the same relative point in other cases. The other explanation is that the gold is derived from the rocks of the neighbouring range which, a little above the occurrence of the gold, are composed of comparatively loose conglomerates which might be the matrix of the gold. Another solution might present itself, namely, that the gold is derived from a dyke of igneous rock which here crosses the creek, and is exposed over a considerable surface of the neighbouring range, but against this is the smooth

water-worn character of the gold, and were it not that the conglomerates above mentioned are of Palæozoic age I should consider that it exists in the said conglomerates as an alluvial gold.

Art. LXXVI.—*On the Belemnites found in New Zealand.*

By Dr. Hector, C.M.G., F.R.S., Director of the Geological Survey.

Plates XXII., XXIII.

[*Read before the Wellington Philosophical Society, 12th January,* 1878.]

Notwithstanding that our knowledge of the true nature and function in the animal economy of the singular fossils comprised in the group *Belemnitidæ* is very imperfect, their importance as indicating particular zones in the life-development of successive epochs has been fully recognized. That they were the internal supports of soft-bodied molluscs allied to the *Sepia* of the present day is certain, but there is no organ strictly analogous to them to be found in the structure of any living form of cephalopod. We are therefore ignorant of the extent to which the variations in form in the fossil belemnites were dependent on or correlated with important modifications in the structure of the complete animal. Nevertheless these varieties are very constant and characteristic of the particular geological formations in which they are found, so that they afford most valuable indications to the stratigraphist.

The *Belemnitidæ* first appear in the liassic period, and survive to the close of the cretaceous period. They are divided into two genera—*Belemnitella*, which is confined to the chalk or upper cretaceous formations, and *Belemnites*, which, with the exception of a single species (in England at least), is confined to the formations below the chalk.

No representative of *Belemnitella*, which is distinguished by a ventral fissure of the guard and external vascular impressions, has yet been discovered in New Zealand, so that in the following notes attention is confined to the genus *Belemnites*.

In order to facilitate the comparison of our belemnites with those described from other countries I reproduce the grouping of the species adopted by Phillips, Mayer, and other writers on the subject, modifying it to comprise the New Zealand forms.

1. Acœli.—Club-shaped and laterally compressed, without dorsal or ventral grooves, but with lateral furrows. (Liassic.)

2. Gastrocœli.—Cylindrical with a distinct ventral groove. (Jurassic.)

3. NOTOCŒLI.—*a. Notosiphiti*: Fusiform, with a dorsal groove, siphuncle on dorsal aspect, and lateral furrows. *b. Gastrosiphiti*: Subcylindrical, with siphuncle on ventral aspect, and short lateral grooves. (Lower Cretaceous.)

Unless it be by certain forms in the liassic strata of the Hokanui and Kaihiku ranges of Southland of which only the large phragmacones have been preserved, the first of these groups has no species in New Zealand representing the *Clavati* of Europe.

In the second group, which includes the sub-groups *Canaliculati* and *Hastati*, there are several species found in the Putataka formation, both in the North and South Islands.

The great majority of forms found in New Zealand belong to the third group, but only to its second section, the first section, representing the *Dilatati* of the European neocomian formations, not being present in our collection. They are very common in the Amuri series, which is equivalent to the lower greensand, and is remarkably rich in belemnites in a perfect state of preservation, but they also survive to the horizon of the upper greensand.

The New Zealand forms of this subdivision are characterized by the absence of any ventral or dorsal grooves, by a variable form—being cylindrical, hastate, or depressed—by the constant presence of short lateral grooves on the upper part of the guard, and the ventral position of the siphuncle that traverses the septa of the phragmacone.

There are five well-marked varieties that might be considered as specifically distinct were they not so intermixed in the same strata. I have referred these to M. Duval-Joave's subdivision *Gastrosiphiti* of the neocomian belemnites, on account of the position of the siphuncle, which is probably of more anatomical significance than the grooves on the external surface of the guard; but in the European species a dorsal groove is always present, whereas it is absent in all the belemnites I would associate in this group from the lower cretaceous formations of India, Australia, and New Zealand.

Group I.—ACŒLI.

1. *Belemnites otapiriensis*, sp. nov.

Pl. XXII., fig 1.

Guard unknown, being only represented by a crushed mass having a longitudinal fibrous structure. Phragmacone with from twenty to thirty septa, slightly elliptical in form, outline forming an angle of 15°. Siphuncle marginal on the major transverse axis, the septa being inserted round the aperture so as to form almost a continuous tube traversing the septa.

This belemnite ranges through the Otapiri series (liassic) down close to the horizon of the *Monotis* beds of the Wairoa series (triassic), and though

it is not actually found with *Monotis*, it is associated with fossils that are also common to the lower triassic formation. It is near to *B. elongatus* of the lias of Britain.

Group II.—Gastrocœli.

A.—Canaliculati.

2. *Belemnites aucklandicus*, Hauer, Novara Exp., Geol., II., 29.

Pl. XXII., fig. 2, *a*, *b*.

According to Dr. Waagen this is very nearly the same as *B. kuntkotensis* of the lower jurassic formations of Kutch,* and, according to Professor Taite, is hardly distinguishable from *B. sulcatus* of the lower oolite of Great Britain.†

Occurs in dark-coloured marly sandstones of the Putataka series, Waikato South Head, and also in similar strata in the Hokanui Range, Southland. In the latter case it occurs in the upper part of the Putataka series, associated with *Trigonia costata* and other middle jurassic fossils.

3. *Belemnites catlinensis*, sp. nov.

Pl. XXII., fig. 3, *a*, *b*.

Guard slender, sub-hastate from being constricted below the alveolus, and widest at the distal third of its length, where the diameter is one-twelfth of the total length and half the length of the alveolus. Phragmacone acute, forming an angle of 18°, with about 16 septa, eccentric, the apex being nearer to the ventral margin. A wide groove extends along the ventral surface from over the alveolus, but disappears short of the apex. In section the guard is slightly compressed. Total length of largest specimen, six inches.

In dark-coloured argillaceous sandstones, south of Catlin River, Otago, and in the Hokanui Range, where it is associated with *Ammonites novæ-zealandiæ*.

This species is very near to *B. fusiformis* of the lower oolite of Britain, and to *B. gerardi* of India;‡ but if faint lateral vascular markings are to be considered as true furrows, as in that species, both this species and *B. aucklandicus* must be classed with the group *Hastati*, in which case no representative of the *Canaliculati* has yet been found in New Zealand.

B.—Hastati.

4. *Belemnites hochstetteri*, sp. nov.

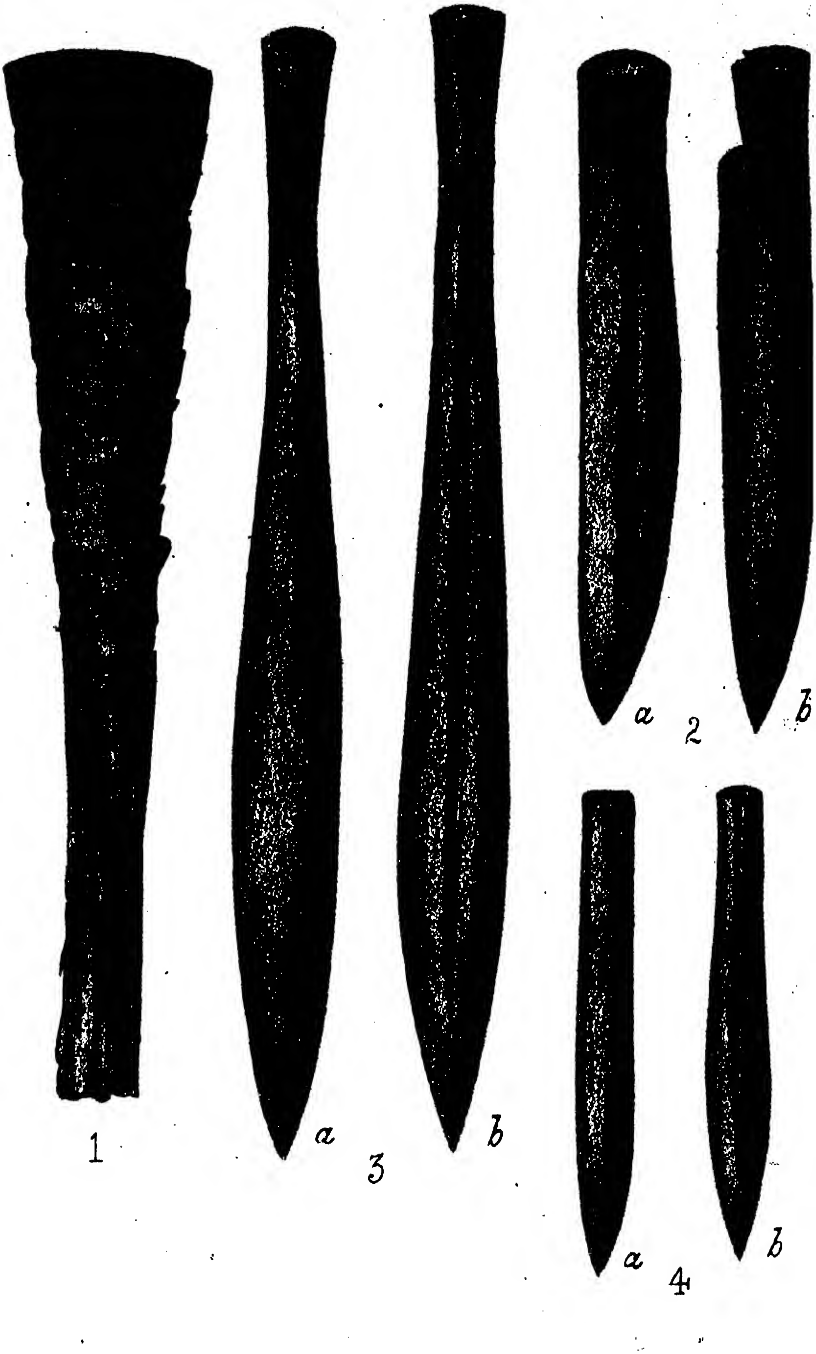
(?) *B. aucklandicus*, var. *minor*, Hauer, Novara Exp., Geol., II.

Pl. XXII., fig. 4, *a*, *b*.

Guard symmetrical, cylindrical, short, with a sharp conical apex. Diameter of guard one-eighth of the total length. Alveolus about one-

* Palæon. Indic., 1873, p. 4. † Q. J. Geol. Soc., XXII., pl. 7.

‡ Waagen, Pal. Ind., 1873, p. 13.



J. Hector, del.

N.Z. BELEMNITES.

J.B. lith.

fourth of the total length. Ventral surface of guard with a broad shallow groove continued almost to the apex, and with distinct lateral furrows on the lower third.

This species is easily recognized from *B. aucklandicus* by the straight central axis of the guard (which is also more slender), the tapering apex, and the well-marked lateral furrows which are discernible in perfect specimens.

From grey calcareous marls with *Inoceramus haastii* that overlie the plant-beds of the Mataura series, Kawhia Harbour, and East Cape district of the North Island. Upper Jurassic.

Group III.—NOTOCŒLI.
B.—Gastrosiphiti.
Pl. XXIII., *α–ε*.

5. *Belemnites australis*, Phillips, Q. J. Geol. Soc., XXXVI., 259.

Belemnites lindsayi, Hector, N.Z. Geol. Rep., 1873-4, xiii.

Deep furrows on the dorsal angles of the lateral areas of the anterior portion of the guard extending only slightly beyond the depth of the alveolar cavity. Angle of the phragmacone from 20° to 30°.

Guard sub-hastate, depressed, trigonal anteriorly, oval in section of middle portion, and terminating in a blunt conical point, sometimes tuberculate at the apex. Length of guard twice that of the phragmacone.

Occurs in the calcareous greensands of the Amuri series at Amuri Bluff and Cape Campbell, and in the upper greensands overlying the brown coal at Waipara, Green Island, Waitaki, and Mount Hamilton.

There is no doubt, I think, that this belemnite is the same species as that described by the late Professor Phillips as a fossil from Queensland, but without any distinct locality or stratigraphical position being assigned to it.

It is probably also identical with *B. seclusus*, Blandford, from the Ootadoor group of the cretaceous formation of India.*

While this species maintains the above general characters with great constancy, the large series of specimens which I am able to exhibit, upwards of sixty in number, show a wonderful variety in the form and proportions of the guard, even in specimens of similar size. Five distinct forms may be described.

Var. α.—Lateral furrows short, deep, and straight. Angle of phragmacone 32°. Guard slightly hastate, with a blunt apex. Alveolar cavity nearly half the length of the guard.

Var. β.—Lateral furrows long, shallow, and sinuous. Angle of the phragmacone 28°. Guard fusiform, depressed on dorsal surface. Apex

* Pal. Ind., 1861, p. 5.

rounded and perforate. Alveolar cavity one-fourth the total length of the guard.

Var. γ.—Lateral furrows long and deep, and curved to the dorsal aspect. The length of the guard is five times that of the fifteen septa in the phragmacone. The form of the guard is hastate, owing to the expansion of the alveolar walls and the tapering of the apex.

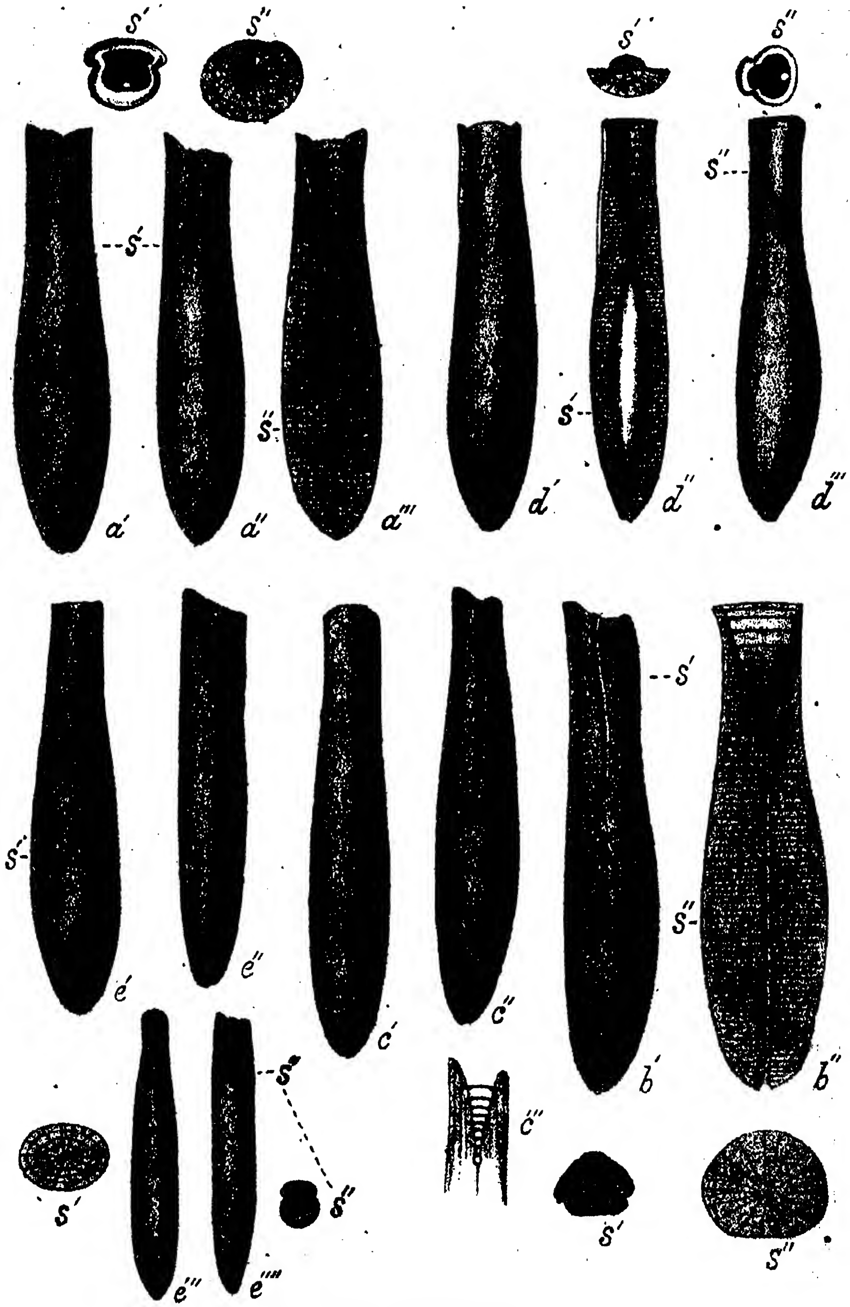
Var. δ.—Guard sub-cylindrical, and constricted at the alveolus. Lateral furrows short, and suddenly reflected to the dorsal aspect. Apex blunt, with a terminal tubercle or knob. Length of alveolus one-fourth that of guard.

Var. ϵ.—Lateral furrows short, deep, and bent towards the ventral aspect. Guard depressed on both dorsal and ventral surfaces. Apex sub-conical. Angle of the phragmacone 25°. Septa very close, numbering 25–30.

The series of sections exhibited illustrate the structure of this belemnite, and especially display the mode in which the central portion of the guard frequently exfoliates, casting from its interior a smooth fusiform body, produced and slightly laminated in structure at the upper end, and blunt with a minute depression or perforation at the lower end. These form the *Acanthocomax* of Miller, and have frequently been mistaken for spines of *Cedaris*. They are not formed, as has been suggested, by the abrasion or weathering of the guard of the belemnite, but are due to its structural arrangement, which, notwithstanding the appearance of radiating prisms in the interior, really consists of concentric laminæ arranged in fusiform layers round the central axis. In some of the specimens the axis is seen to be an open canal filled with the sand of the imbedding matrix. This canal seems to be continuous with the siphuncle that traverses the septa of the phragmacone, and to perforate or be a continuation of the conotheca, passing on one side of the spherical pellet or nucleus that forms the apex of the phragmacone.

None of the varieties into which I have sub-divided *Belemnites australis* can be considered to have a peculiar horizon or stratigraphical distribution. The lower greensand in the Amuri section has been divided as follows in descending order:—

1. Black grit or car-stone.
2. *Aporrhais ornata* beds.
3. *Trigonia sulcata* beds.
4. Belemnite beds.
5. Calcareous conglomerate.
6. Wood sands.



N.Z. BELEMNITES.

J. Hector, del. J.B. lith.

Belemnites first appear in the calcareous conglomerate, and constitute the whole mass of the belemnite beds, almost to the exclusion of other fossil forms, but they continue plentiful up to the black grit, in which they become scarce.

The next bed above the black grit is the boulder sand or saurian bed, and in this no belemnites have been found; but they again appear in the concretionary greensands, but are there represented only by the peculiar forms which I have shown to result from the exfoliation of the perfect guards, and no trace of a belemnite possessing the upper part of its guard or phragmacone has been discovered in any bed above the black grit. This disappearance of the perfect belemnites in the upper greensand strata may be, I think, accounted for by the gradual change in the nature of the matrix, and the accession of the same unfavourable circumstances which led to the extinction of the race.

EXPLANATION OF PLATES.

PLATE XXII.

Fig. 1. *Belemnites otapiriensis*, sp. nov.
Fig. 2. *Belemnites aucklandicus*, Hauer.
a. ventral, *b*. lateral aspect.
Fig. 3. *Belemnites catlinensis*, sp. nov.
a. lateral, *b*. ventral aspect.
Fig. 4. *Belemnites hochstetteri*, sp. nov.
a. lateral, *b*. ventral aspect.

PLATE XXIII.

Belemnites australis, Phillips.

Var. α. *a'*. dorsal, *a''*. lateral aspect.
a'''. longitudinal section.
s'. transverse section of phragmacone.
s''. do. of guard.
Var. β. *b'*. lateral aspect, *b''*. longitudinal section.
s'. transverse section of phragmacone.
s''. do. of guard.
Var. γ. *c'* ventral, *c''*. lateral aspect.
c'''. longitudinal section of alveolus.
Var. δ. *d'*. ventral aspect, *d''*. longitudinal section, showing exfoliation of the central core, *d'''*. lateral aspect.
s'. transverse section of guard.
s''. do. of phragmacone.
Var. ε. *e'*. dorsal, *e''*. lateral aspect.
e'''. dorsal, *e''''*. lateral. aspect, *juv*.
s'. transverse section of guard.
s''. do. of phragmacone, *juv*.

away, and the number of households to whom it was presented, varies with the abundance of food cooked that day, but there is a certain minimum of people who must be thus treated every day. This custom is called *Vevéni* (in Motu, *Hierahia)*, and as far as I have been able to ascertain it prevails among all the Papuo-Melanesians.

This *Vevéni* food must, in the first place, be sent to the father's house, in the case in which the father and son do not live under one roof. Then come the "own" (blood) brothers, and afterwards, when food is plentiful, the first paternal and maternal cousins and the uncle are presented with food. Of course, the same people return the presents to the donor in a corresponding degree of frequency and abundance. As a rule the natives, when asked to which houses they send the *Vevéni*, give a definite number, which is usually some three to five, a fact which shows that normally there is a fixed number of people with whom the interchange of food takes place. If food is scarce, and both his parents dead, he gives the *Vevéni* to his elder and younger own brothers, and to his sister. If he has sufficient food he shares it with his half-brother and half-sister, of the same father but of different mothers. In cases of exceptional abundance he sends food to his paternal and maternal cousins (tribal brothers) in equal shares.

Food: Raw Materials and Preparation of Food.—The animal food of the natives consists of game, such as pigs, wallabies, kangaroos, rats, bandicoots, cuscus, and various birds, and of fishes and shellfish. The inland *Mágí* had a better supply of land game and the Toulon islanders had a greater abundance of fish, but all the villagers are both hunters and fishermen (see chap. iv.). Moreover, fish seems to be a much more easily and regularly accessible form of food for those natives who live near the sea than game is for the inland natives. Pork is derived from two sources—the wild boar, which is hunted, and the pigs that are bred in the village. The village pigs, which are the more valued, are killed only on the occasions of important feasts (*cf.* chap. v., sec. 3).

Vegetable food is undoubtedly far more important in native households than animal food. In the Mailu district, as in all wet regions of Papua, the predominant vegetable food consists of bananas and taro, bananas occupying the first place. Of these there are very many kinds indigenous to the country, and now there are, besides, several introduced sorts. There are four kinds of indigenous taro and four kinds of yams. There is another tuber, called in Motu *Taitu*, of which there are several varieties. Sago grows in many places, and every village possesses its sago swamp and coconut plantation. Nowadays the

introduced sweet potatoes and pawpaw constitute an extremely important item in native housekeeping.

The bananas are eaten ripe as a fruit, but their chief culinary use is to be eaten as vegetables, for which purpose they are used in the green, unripe state. They are not peeled, but only cleaned and their ends cut off. The taro is cleaned, scraped, and, when it is very bulky, chopped into large chunks. The same applies to the yam and *Taitu* roots, and to the sweet potato—a recent introduction to Papuan soil. The pawpaw is also used green, as a vegetable. The scraping of the taro, yam, and *Taítu* is done with a *Cypraea tigris* shell *(Gúna)* cut in half and sharpened. Taro and yams are chopped into pieces with a pearl shell *(Meleagrina* sp.; in Mailu, *Oráva)* sharpened into a fine blade. The scraping of bananas is also performed with a shell, of which two kinds are used, one very small and called *Ku'i'i*, and the other slightly larger and called *Nika'i'i;* both are of the same shape.

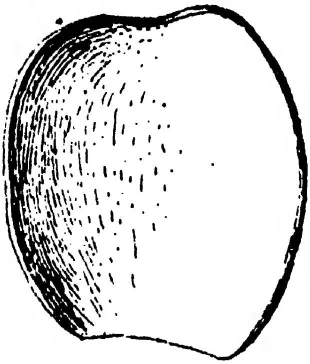


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Fig. 17.

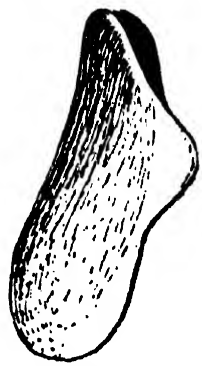

Fig. 18.

VEGETABLE AND FRUIT SCRAPERS.

Fig. 17. *Gúna*, a vegetable scraper, made of the top half of a *Cypraea* shell, sharpened into a blade at the end A.

Fig. 18. A small, naturally sharp-edged, bivalve shell, used as scraper; called *Ku'i'i* (smaller species) and *Nika'i'i* (larger species).

Cooking and Dishing-up.—If the food is boiled, both vegetable and animal foods are cooked in the same pot. There are three methods of cooking used by the Mailu natives: boiling, roasting, and baking with hot stones.

Boiling *(Dáridári;* in Motu, *Nadúa)* is done in one of the large earthenware pots, which are manufactured on Toulon Island and in its direct colonies *(Domára, Oraído*, and

Calcite.—Dunedin.

In rhombohedral crystals lining an amygdaloidal cavity. The terminal group of rhombohedral faces (arranged in groups of three) have a bright lustre; but the faces of the prism or elongated rhombohedron have drusy and brown-coloured surfaces.

Calcite.—Chalky Inlet.

A cleavage rhombohedron; opaque white, but almost transparent in parts.

Calcite.—Moeraki.

From a septarian; of a yellow colour; the under surface is studded with dark brown-coloured spots, which are apparently imperfectly-developed rhombohedral crystals. These spots are rich in iron and manganese. Before the blow-pipe the yellow colour is changed to black; due to the presence of iron. One side of the specimen is irregular, from the presence of bold, but imperfectly-defined scalenohedral crystals.

Calcite.—Sunnyside, Dunedin.

Smoky, translucent crystals of calcite, made up of the rhombohedron combined with the scalenohedron. Associated with them are radiate groups of acicular natrolite crystals.

Calcite.—Dunedin.

The crystals are small, fairly well-developed acute rhombohedra, arranged together in a most beautiful little group; the crystals are of a pleasing brown colour, with drusy surfaces. The calcite crystals are seated upon a thin coating of natrolite, which lines the amygdaloidal cavity. On the brown rosette of calcite is seated, in turn, a pretty little group of clear transparent crystals of some zeolite, apparently skolezite.

Calcite.—Dunedin.

In pale yellow transparent rhombohedral crystals; lining a cavity.

Calcite.—Dunedin.

Similar to the above.

Calcite.—Dunedin.

In small white rhombohedral crystals, seated on a pale brown-coloured calcite, lining an amygdaloidal cavity.

Calcite.—Dunedin.

Group of fairly well-developed rhombohedral crystals; pale greenish tint, translucent.

Calcite.—Sunnyside, Dunedin.

Small brown translucent crystals, consisting of the scalenohedron and rhombohedron combined; associated with one of the zeolites. The zeolite fuses easily to a clear glass, without intumescence.

Calcite.—Dunedin.

In brown transparent crystals, made up of similar forms to the last. Lustre vitreous. Associated with the calcite are radiate groups of natrolite crystals, and both are seated upon a pale blue-coloured film of a minutely crystallized zeolite, which has some of the characters of gismondine.

Calcite.—Dunedin.

In group of translucent pale green-coloured crystals, lining an amygdaloidal cavity.

Calcite.—Dunedin.

A group of brown imperfectly-developed crystals.

Calcite.—Dunedin.

In radiate groups of small crystals, composed of the scalenohedron and rhombohedron combined; well developed, although almost microscopic in size.

Translucent; lustre vitreous; in amygdaloidal cavity. There is also present in the specimen a cast or impression of a radiate group of acicular arragonite crystals.

Calcite.—Dunedin.

A group of clear, transparent, and colourless crystals, with vitreous lustre. The forms are flattened elongated rhombohedra, which penetrate right across the cavity and abut against the opposite side.

Calcite.—Dunedin.

A radiated group of crystals consisting of the scalenohedron and rhombohedron combined.

*Arragonite.**—Dunedin.

Filling amygdaloidal cavities in basalt.

Arragonite.—Caversham.

Long blade-like prisms in an amygdaloidal cavity lined with the zeolite natrolite.

Arragonite.—Dunedin.

In radiate rhombic prisms of a pale pink colour, with vitreous lustre. The cavity is lined with small rhombohedral crystals of pale yellow calcite.

Arragonite.—Dunedin.

Beautiful rosettes of pale yellow-coloured prisms with vitreous lustre. The under portions are much charged with iron, and in consequence present a brown colour. Presented by Captain Fraser.

Selenite.†—Moeraki.

A clear and transparent form of gypsum, (*i.e.*, hydrous calcium sulphate=$Ca\ SO_4,\ 2H_2O$); roughly crystallized; valuable for the preparation of various cements.

* Rep. N.Z. Exh., 1865, p. 487. † Rep. N.Z. Exh., 1865, p. 422, 487.

Gypsum or Selenite.—Awamoko.

In thin roughly crystallized plates, mixed with black shaly matter.

*Gypsum.**—White Island.

Associated with sulphur in thin columnar crystals somewhat interlacing; opaque white; somewhat fibrous in structure.

Gypsum.—Wakatipu.

A white, opaque, mammillated incrusting mass, from a cave at Mr. Nicholas', Lake Wakatipu.

Vivianite.†

A small rolled nodule of a dull blue colour, and earthy appearance; breaks with a flat conchoidal fracture; hardness=3; streak pale blue; almost entirely soluble in acid.

Analysis.

Hygroscopic moisture	3·017	or loss at 100° C.
Combined water	21·425	by difference
Iron protoxide	28·177	Soluble in hydrochloric acid
„ sesquioxide	16·363	
Phosphoric acid	31·018	
	100·000	(Liversidge).

Quartz.—Hendon.

White vein quartz, with clear transparent crystals on one surface made up of the hexagonal prism combined with the pyramid. (∞ P, mP.)

Quartz.—Milford Sound.

Translucent white, much fissured, and in consequence almost granular in structure.

Chalcedony.—Moeraki.

Massive; bluish-grey colour; translucent, with small quartz crystals in the cavities.

Chalcedony.—Otepopo.

Mammillated; translucent; grey with yellow patches.

Agate.—Mount Charles, Otago.

A mixture of grey chalcedony and quartz crystals stained with a little hydrated sesquioxide of iron.

Flint.—Moeraki.

Grey, with brown and dark blue-grey streaks, fissured; conchoidal fracture; pitted on the weathered surface, which is grey in colour.

Chert.—Amuri Bluff.

Somewhat chalky appearance, exhibiting bluish and yellowish tints; white in parts. Hardness about 6·5. Effervesces with hydrochloric acid.

* Trans. N.Z. Inst., III, 280. † Rep. N.Z. Exh., 1865, p. 436.

Chert.—Waihola.

Of the colour of yellow-ochre; cavities lined with bluish-coloured quartz and chalcedony? The translucent grey portions, when heated in a closed tube, decrepitate somewhat, give off water, a slight white sublimate and fumes of sulphurous acid; does not blacken; the ochre-coloured portions give off water, a slight sublimate similar to the last is formed, and an empyreumatic odour is evolved; the residue blackens (but finally burns to a reddish-brown, due to the presence of iron oxide), and the condensed water has a strongly alkaline reaction, all of which tend to indicate that organic matter is present. The hardness of the ochre-coloured part is greater than that of the grey portion, the former being about 6·5, and the latter not more than about 5·5.

The blue-grey portion appears to be a film of chalcedony (or hyalite) coating small and imperfect quartz crystals.

Carnelian.—Coromandel.

Two specimens of reddish-brown carnelian or chalcedony, but wanting purity of colour and translucency.

Carnelian.—Coromandel.

Colourless, transparent carnelian.

Hardness only about 5·5. Heated in closed tube the specimen gives off a trace of water, having an alkaline reaction, and evolves a faint empyreumatic odour; conchoidal fracture with vitreous lustre.

Flint.—Tapanui.

A brown-coloured water-worn nodule, closely resembling the flint from the chalk of England.

Flint.—Wangarei Heads.

Water-worn nodule, variegated grey and white colour, somewhat fissured. Unlike the chert from Amuri Bluff it does not effervesce with acids.

Chert.—Otago.

Of a pale green colour.

Chert.—Otago.

Possessing an impure lavender colour.

Jasper.—Clutha.

Portion of a waterworn nodule, sliced and polished; of a pale green colour, streaked with darker shades; fissured, showing "faults" which are made plainly visible by the bands of darker colour.

Green Jasper.—Moeraki.

Variegated with reddish-brown streaks; a little chalcedony on one surface. The green colour is mainly due to the presence of protoxide of iron; there is also manganese present in small quantity. On heating in a

closed tube it decrepitates slightly, blackens and gives off water having an alkaline reaction; there is also a slight empyreumatic odour evolved.

Pitch Opal.—Dunstan.

Brown, variegated, light and dark shades. Hardness about 6. When heated in closed tube gives off water, blackens and emits empyreumatic odour; the condensed water has an acid reaction, and on evaporation leaves a carbonaceous residue which blackens on ignition; breaks with a well-marked conchoidal fracture. Contains iron.

Opal Jasper.—Near Dunedin.

A prettily marked ornamental stone, the predominant colours bieng red-brown, blue-grey, and opal-white. Hardness about 6.

Hyalite.—Bell Hill, Dunedin.

Mammillated, colourless; opaque white in part, lining cavity in vesicular grey trachyte.

Quartzite.

An altered or metamorphosed sandstone, containing fragment of fossil.

Siliceous Sinter.—Hot Springs, Waikato.

In stalactitic forms; opaque white; somewhat tender and friable; when heated in closed tube, gives off water having a neutral or but faintly acid reaction, also emits a slight empyreumatic odour; cracks and breaks up into small fragments. This deposit, in common with other similar ones, does not consist of pure silica; but contains some alumina, iron, lime, alkalies, etc.

Jasper.—Clutha, Dunstan.

Rolled nodule, dark reddish brown with veins of white quartz.

Jasper.—Clutha.

Very impure.

*Hornblende.**—Lake McKerrow.

Massive; cleavage planes fairly well marked.

Hornblende.—West Coast.

Massive; large confused crystals; greenish-black colour.

Hornblende.—Kakanui Mountains.

Fragment of a large crystal; well-marked cleavage planes; black.

Hornblende.—Dun Mountain.

Labelled "amorphous hornblende," shows a jointed structure; breaks with a subconchoidal fracture; has a somewhat greasy feel like serpentine.

Diallage.—Lake McKerrow.

Foliated and confused masses of crystals; colour green; lustre not well-marked.

* Rep. N.Z. Exh., 1865, p. 488.

Hornblende.—Dunedin.

Portion of an embedded crystal.

Diallage.—Dun Mountain.

In large confused crystals, with well-marked lamellar structure.

Hypersthene.—Warp Point, Kaduku River.

In small confused dark green-coloured crystals.

Chloritic Schist.—Deep Creek, Kakapo Lake.

Composed of green-coloured chlorite in part, passing into fibrous, wavy, and interlacing crystals of hornblende.

*Olivine.**—Dunedin.

Brown-coloured embedded grains, possessing a green shade; fragmentary or imperfectly-developed crystals.

Steatite.—Nelson.

Massive, with somewhat foliated structure; greenish in colour. Should be of commercial value for the manufacture of gas-burners, the preparation of French chalk, etc.†

Serpentine.—Windley Creek.

Massive; of a dull green colour; translucent. This is the mineral serpentine, and not the rock which is known by that name.

Marmolite.‡—Anita Bay.

A foliated form of serpentine, which resembles nephrite (the mineral known as jade or greenstone, the pounamu of the Maoris) in some respects; it is, however, at once distinguished by its softness.

Green in colour, and possesses a hardness of about 4.

Marmolite ?§ (Steatite ?).

Pale green folia, on serpentine, containing hypersthene; greasy feel; hardness about 3·5; rather brittle.

Chloropal.—Presented by Captain Fraser.

Of a yellowish-green colour; somewhat foliated cone-in-cone structure; sectile; soft; easily polished, even by rubbing with the thumb; adheres slightly to tongue: when immersed in water gives off air-bubbles, and becomes translucent.

Before the blow-pipe does not decrepitate; blackens immediately, and fuses with difficulty in thin edges, with slight intumescence, to a black glassy slag.

Mica (Muscovite).—Charleston, West Coast.

In large plates; brown with greenish shades and metallic lustre.

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* Contains chromium, Rep. N.Z. Exh., p. 413. † Geol. Reports.

‡ Rep. N.Z. Exh., 1865, p. 412. § Rep. N.Z. Exh., 1865, p. 412.

Analysis.

Silica	45·007
Iron sesquioxide	4·188
Alumina	37·144
Potash	10·049
Lime	·517
Magnesia	1·286
Undetermined constituents, water, soda, etc.	1·859
	100·000 (Liversidge).

Presented by Mr. C. H. Hardy.

Mica.—Dusky Bay.

In medium-sized plates; brown in colour; associated with quartz and a little decomposed garnet.

Felspar (Albite)*—George Sound.

Fairly well-marked cleavage planes, white, small red stains on weathered surface; fuses more easily than orthoclase.

Orthoclase.—Paterson Inlet.

Massive, presenting large cleavage planes, of the ordinary pale pink-brown tint. Attached to one end of specimen is some graphic granite or pegmatite.

Presented by Mr. Kinnear.

Orthoclase.—Cooper Bay.

Similar to the last.

Presented by Mr. Kinnear.

Orthoclase.—Cooper Bay.

Rolled specimens, contain embedded quartz crystals.

Granite.—Milford Sound.

Labelled "lithia mica.†"

A mixture of white felspar and black mica. No lithia could be detected in this specimen; both the mica and felspar appeared to be free from it, according to qualitative tests; therefore, to make doubly sure, the alkalies in both the mica and the felspar were separated and again examined for lithium, but with negative results.

Alkalies in the Mica.

Potash	3·823
Soda	2·136
	5·959 per cent. (Liversidge).

* Rep. N.Z. Exh., 1865, 437.

† Lithia mica occurs in marble at Thomson Sound. Rep. N.Z. Exh., 1865, 437.

The mica was not perfectly pure; it was found difficult to separate it completely from the other constituents of the rock; the difficulty was mainly due to the smallness of the quantity at my disposal.

Alkalies in Felspar (Albite).

Potash	1·071
Soda	5·590
	6·661 per cent. (Liversidge).

Garnet.—Breaksea Sound.

An embedded crystal (the rhombic dodecahedron) broken across. The matrix is syenite, having the wavy foliated structure of gneiss. Immediately around the garnet the hornblende is almost entirely absent, which causes that part of the matrix to be much lighter in colour, and consequently the garnet is shown up to much greater advantage.

It is highly probable that the hornblende and garnet are not very dissimilar in chemical composition, and that when the rock underwent metamorphism, and its constituents were free to re-arrange themselves, the garnet "nucleus," or centre of crystallization, had the power to abstract and build up certain of the rock constituents which would have otherwise assumed the form of hornblende. Hence the probable reason of the absence of hornblende in the immediate neighbourhood of the garnet. It would be very interesting to put this suggestion to the proof by chemical analysis, should additional specimens be obtainable.

*Limestone.**—Crooked Arm, West Coast.—(Labelled "Cipillino.")

A white saccharoid limestone or marble, containing small crystals of brown mica, a little quartz, and a few scales of graphite.

The variety of marble known as cipillino contains talc or chlorite, hence it is marked by green-coloured streaks and veins.

This specimen cannot therefore be classified with it.

Analysis.

Carbonic acid	38·284
Iron sesquioxide and alumina	1·253
Lime	48·269
Magnesia	·402
Mica, silica, etc, insoluble in acid	9·459
Undetermined constituents	2·333
	100·000 (Liversidge).

Halloysite.†—Water of Leith, Dunedin.

An opaque white earthy substance, soft and soapy; associated with it is a little black halloysite; when immersed in water it gives off air bubbles

* Report West Coast Expedition, Otago Gazette, 1863, 459.

† Rep. N.Z. Exh., 1865, 438.

rapidly, accompanied by a singing sound; falls to pieces, and becomes translucent on the thin edges; breaks with a conchoidal fracture; adheres strongly to the tongue; yields to the thumb nail and affords a shining streak; possesses an earthy smell.

Schrötterite?—Malvern Hills. (Labelled "Pinite.")

In rounded wax-like masses, filling the cavities of an amygdaloidal trachyte (?) rock, and as a mammillated incrustation upon its surface; green, grey, and white; hardness about 3·5; streak white, rather tough; breaks into more or less conchoidal flakes; translucent; waxy lustre. Before the blow-pipe it becomes white and opaque, and much harder (thus differing from the ordinary behaviour of both pinite and allophane), intumesces slightly, and tinges the flame green; affords deep blue when ignited with cobalt nitrate; does not gelatinize with hydrochloric acid, but granular silica is thrown down; gives off much water when heated in closed tubes.

ZEOLITES.*

Natrolite.—Sunnyside, Dunedin.

In radiated tufts of white acicular crystals, and coating a hemispherical concretion of ferruginous calcite.

Presented by Mr. D. Millar.

Natrolite.

In beautiful radiated tufts of acicular crystals.

Natrolite.—Dunedin.

Natrolite.—Dunedin.

Natrolite.—Dunedin.

Associated with an incrustation of siderite or iron carbonate.

Natrolite.—Dunedin.

Compact form, exhibiting radiate structure; lining amygdaloidal cavities in basalt.

Natrolite.—Dunedin.

Forming a thin investing coating on interior of amygdaloidal cavity.

Stilbite?—Dunedin.

In the cavities of these specimens are minute detached crystals of one of the zeolites. The form appears to be that of the rhombic prism capped with the pyramid; this is a combination often assumed by stilbite, and in addition the little crystals possess a very high lustre, not unlike that of stilbite; moreover, they behave like that mineral before the blow-pipe, hence they probably belong to the same species.

Not sufficient to permit an analysis to be made without destroying the specimens completely.

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* Rep. N.Z. Exh., 1865, p. 438.

METALLIFEROUS MINERALS.

*Platinum.**—Southland.

In the form of small flattened grains.

On account of the smallness of the specimen, I did not think it advisable to use any portion of it for chemical examination; and, moreover, Professor Black has published the results of his examination of a sample from the Bluff, which is apparently very similar to this specimen.

He states—"It consisted of from 35 to 42 per cent. of platinum (black or magnetic oxide of iron not estimated), and an alloy of platinum, osmium, and iridium."—*Vide* Geology of Otago, p. 149.

Auriferous Quartz.—Taieri Goldfield.

From the prospectors' reef in a gully leading into Frazer's Gully. Thickness of reef, 3 feet.

Contains visible gold.

Auriferous Quartz.—Adelaide Reef, Taieri.

Vein-quartz, stained with iron oxide. But a small quantity of visible gold present.

Auriferous Quartz.—Adelaide Reef, Taieri.

White vein-quartz.

Auriferous Quartz.—Blacksmith's Gully.

Vein-quartz, containing visible gold; from surface.

Auriferous Quartz.—Sorensin's Old Reef, Skippers.

Of a bluish colour, rich in visible gold.

Auriferous Quartz.—Nevis River.

Four specimens of more or less crystallized quartz.

Auriferous Quartz.—Serpentine River.

Contains a small quantity of visible gold.

Auriferous Quartz.—Pleasant River.

Contains visible gold, especially near the talcose vein.

Auriferous Quartz.—Adelaide Reef.

Two specimens, containing but a small quantity of visible gold.

Auriferous Quartz.—Hendon Reef.

Brownish-coloured hornstone-like quartz, marked with grey streaks; contains visible gold.

Auriferous Cement.—Tuapeka (from the Blue Spur.)

A mass of quartz, schistose, and other pebbles, mixed with much water-worn shotty gold, cemented together by a chloritic base.

Presented by Mr. Nichol.

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* 4th Lab. Rep., 1869, No. 486.

Native Mercury.—Tokomairiro.

In the form of minute globules, mainly more or less hidden away in the crevices. The dark veins contain, in addition to mercury, both copper and sulphur.

*Cinnabar.**—Waipori.

In the form of rolled fragments, which show traces of crystallization in the cavities. A very rich and highly valuable ore of mercury.

Cinnabar.—Bay of Islands.

Earthy and associated with petroleum.

Native Copper.—Moke Creek. Presented by Mr. J. S. Worthington.

Rolled nodule, somewhat cavernous, more or less coated with cuprite (the red oxide) and malachite (hydrous green carbonate of copper); associated with them are adherent fragments of quartz evidently a portion of the veinstuff.

Cuprite.†—Dun Mountain.

Impure, coated in part with green carbonate of copper. When pure this ore contains 88·8 per cent. of metallic copper.

Bornite.—Dunstan.

In micaceous quartz with a somewhat schistose structure, mixed with a little common copper pyrites and green carbonate. One portion is from a rolled nodule. This variety of copper pyrites, when pure, contains about 70·1 per cent. metallic copper.

Chrysocolla.—Nelson.

A specimen of the impure green hydrated silicate of copper.

Chalcopyrite.—Moke Creek.

The common variety of copper pyrites.

Mispickel.—Collingwood, Nelson.

In small but fairly well-formed crystals. This mineral is an arsenical sulphide of iron.

Antimonite.‡—Union Jack Reef, Mullocky Gully.

Massive crystallized sulphide of antimony, associated with cervantite, the yellow oxide of antimony, and some quartz.

Wad.§—Thames Goldfield.

An impure earthy form of manganese binoxide; associated with quartz.

Rhodonite.||—Dunstan.

A massive form of the silicate of manganese, mixed with a little binoxide of manganese. This mineral forms a very beautiful ornamental stone when cut and polished.

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* Rep. N. Z. Exh., 1865, p. 404. † And others, Rep. N. Z. Exh., p. 405.
‡ Rep. N.Z. Exh., p. 404. § Geol. Reports, 1870, p. 87. || Rep. N.Z. Exh., p. 413.

*Scheelite.**—Blackburn.

A massive specimen of calcium tungstate in rolled nodules ; contains a little quartz.

Scheelite.—Lake Wakatipu.

Very much the same as the last.

Galena.—Tokomairiro.

This is the common ore of lead, a compound of lead and sulphur; associated with quartz.

Presented by Mr. Gillies.

Galena.†—Wangapeka.

Rolled nodule of quartz, containing veins of galena.

Galena.—Nelson.

Associated with quartz.

Magnetite.‡—Dunstan.

A rolled nodule of the magnetic oxide of iron ($Fe_3\ O_4$), containing quartz.

Magnetite.—Maori Point, Shotover.

Massive, with a granular structure. Stained with green carbonate of copper.

Magnetic Iron Sand.—Awamoko Creek, Marawhenua Goldfield.

The specimen consists principally of rolled grains of magnetite and of titaniferous iron ; associated with them are a few zircons (hyacinth), a little gold, brown hematite, a little quartz sand, and pieces of iron from tools.

Magnetite.—Nelson.

Massive, impure ; stained in places with green carbonate of copper. Associated with it is a compound silicate of iron, lime, magnesia, potash, and soda.

Specular Hematite.—Longwood Mountains.

In small lamellar and granular masses, embedded in quartz.

Red Hematite.—D'Urville Island.

Massive ; of very good quality.

Red Hematite.—Horseshoe Bush.

A botryoidal concretion of sand, cemented together by red oxide of iron.

Brown Hematite.—Dunstan.

A hollow nodule of the variety of iron ore known as limonite. Of very good quality ; when fairly pure this ore contains some 55 per cent. of metallic iron ; the red variety of hematite may contain as much as 70 per cent. ; and magnetite, which is the richest, may yield 72 per cent. of iron.

* Rep. N.Z. Exh., p. 414. † 5th Lab. Rep., 1870, No. 886.

‡ And others, Rep. N.Z. Exh., 1865, p. 407.

		Metallic iron.
When chemically pure, Brown Hematite contains	...	59·89
,, ,, ,, Red ,, ,,	...	70·03
,, ,, ,, Magnetite ,, ,,	...	72·40

Brown Hematite.—Lansdowne, Port Molyneux.

Exhibiting a concretionary and cavernous structure. Labelled 65 per cent. of iron.

*Siderite.**—Dunedin.

Groups of small brown-coloured rhombohedral crystals of the carbonate of iron; the rhombohedra are piled up into little columns. Lining cavity in basalt.

Magnesian Ironstone.—Clutha.

A rolled nodule. Hardness about 6; tough; somewhat splintery fracture. Contains some manganese. Effervesces slightly with boiling hydrochloric acid.

Dendritic Iron Markings.—North-East Valley.

Presented by Mr. R. Hempseed.

Chromite.—Moke Creek, Queenstown.

Of rich quality; granular in structure; incrusted in part with chrome ochre.

Chromite.—Dun Mountain.

Of rich quality; granular structure; attached on one side is a little serpentine.

Chromite.†—Milford Sound.

Rich quality; a rolled nodule; granular structure; associated with a little steatite.

Iron Pyrites.—Shotover.

In well-developed cubes, embedded in chlorite schist.

Iron Pyrites.—Maori Point, Wakatipu.

In large cubes embedded in a similar chlorite schist to the above.

Native silver.—Kawaru.

Small specimen; tarnished with (Ag_2 S) coating of sulphide.

N.B.—(Should have followed native platinum.)

Presented by Dr. Alexander.

MISCELLANEOUS.

Quartzite in Basalt.—Near Mount Livingstone.

An angular fragment of quartzite, embedded in a porphyritic basalt.

To determine whether the enclosed fragment consisted of pure silica, the following estimates were made :—

Silica ..	.. ..	85·030
Sesquioxides of iron and alumina	.. .. ..	4·878

* Rep. N.Z. Exh., p. 436. † Rep. N.Z. Exh., p. 410.

From which it will appear that the enclosed fragment cannot be regarded as quartz but rather as quartzite; it is probably a portion of some sedimentary rock which has been metamorphosed by the action of the fluid basalt.

*Taranakite.**—Taranaki.

ART. LXXVIII.—*Analyses of a Rock Specimen from New Zealand, showing the Junction between Granite and Slate.* By ARCHIBALD LIVERSIDGE, Professor of Geology and Mineralogy in the University of Sydney. Communicated by Professor HUTTON.

[*Read before the Otago Institute, 8th November*, 1877.]

I AM indebted to the kindness of Capt. Hutton, F.G.S., Director of the Museum, Dunedin, for an opportunity to examine this most interesting specimen; although the dimensions of the specimen were originally only about one and a-half inches by one and three-quarters, and perhaps one inch in thickness, yet one-half of the specimen consisted of a fine-grained greenish grey-coloured slate, while the remaining portion was made up of a nearly white granite, possessing well-defined characteristics; the crystals of orthoclase felspar are fairly well-defined and exhibit comparatively large cleavage planes; the mica and quartz are also distinctly developed; even in so small a fragment the granite does not merge so insensibly into the slate as we might naturally expect, but the two are joined along a comparatively well-defined line of junction.

The following analytical results, which are each the mean of two analyses, show the differences in the chemical composition between the granite and slate portions of the specimen.

Analysis of the Granite.

Moisture driven off at 105° C.	.287
Silica	65·006
Alumina	17·371
Iron sesquioxide	3·237
„ protoxide	·872
Phosphoric acid	absent
Manganese protoxide	·393
Lime	2·145
Magnesia	·725
Potash	3·294
Soda	3·809
Carbonic acid	traces
Undetermined constituents and loss	1·861
	100·000

Specific gravity = 2·619.

* Rep. N.Z. Exh., 1865, p. 423.

Analysis of the Slate.

Moisture driven off at 105° C.	·475
* Water lost at a red heat	3·143
Silica	52·259
Alumina	20·724
Iron sesquioxide	2·207
„ protoxide	5·094
Phosphoric acid	absent
Manganese protoxide	1·727
Lime	2·984
Magnesia	4·199
Potash	4·358
Soda	3·072
Carbonic acid	traces
	100·237

Specific gravity = 2·718.

It will be at once observed that there is far less silica in the slaty portion than in the granitic, and that the bases have undergone a corresponding increase in their amounts; this is most noticeable in the percentage of iron, alumina, manganese, and magnesia. The increase in the proportions of the bases present has been accompanied by a rise in the specific gravity of the slaty portion.

Note.—This specimen was obtained by myself in Isthmus Sound, Preservation Inlet. See "Geology of Otago," Dunedin, 1875, p. 40.—F. W. H.

* This was estimated by direct weighing in a calcium chloride drying-tube.

NEW ZEALAND INSTITUTE.

NEW ZEALAND INSTITUTE.

Ninth Annual Report, 1876-7.

Since the last annual report, meetings of the Board were held on the following dates:—19th September, and 19th December, 1876; 17th May, and 9th July, 1877.

The following members of the Board retired in conformity with the sixth clause of the Act, and were on the 11th January, 1877, re-appointed by His Excellency the Governor—viz., the Hon. Mr. Waterhouse, the Hon. Mr. Stafford, and Dr. Hector.

The elected Governors by the Incorporated Societies, in accordance with clause 7, were Mr. J. C. Crawford, Mr. J. T. Thomson, and Mr. T. Kirk.

Under Statute IV. of the Rules of the Institute, the under-mentioned were elected honorary members of the New Zealand Institute: The Rev. W. B. Clarke, M.A., F.R.S.; Professor Etheridge, F.R.S.; and Dr. S. Berggren.

The roll of the Institute now numbers as follows:—

Honorary members	25
Ordinary Members.	
Wellington Philosophical Society	224
Auckland Institute	285
Philosophical Institute of Canterbury	95
Otago Institute	231
Nelson Association	50
Westland Institute	76
Hawke Bay Philosophical Institute	69
Total	1,055

Copies of Vol. IX. have been as usual distributed to the members and in accordance with the free list appended to the volume, the edition having been increased from 1,000 to 1,250 volumes to meet the increased demand.

The publication of the volume for 1876 (IX.) was commenced in December of that year, but owing to the large increase in the number of original articles, and also to the fact of an additional number of papers being sent in when the volume was considerably advanced, it was not completed until the end of May, 1877.

The late date at which some papers reached the Editor also prevented the thorough classification of the contents of the volume; and it would greatly facilitate publication if future communications to the different affiliated societies were forwarded to the Manager of the Institute immediately after they have been read before the society.

It may be stated, in illustration of the necessity for such a practice being adopted, that when the printing of Vol. IX. was begun the amount of manuscript in hand would not have made more than 200 pages.

The ninth volume is the most voluminous of any hitherto issued, containing no less than 96 articles, 80 plates, and 724 pages of letter-press.

As compared with last year's issue, the sections of the work are as under :—

	1877.	1876.
Miscellaneous	316 pages.	179 pages.
Zoology	178 ,,	181 ,,
Botany	61 ,,	81 ,,
Chemistry	7 ,,	20 ,,
Geology	42 ,,	39 ,,
Proceedings	62 ,,	50 ,,
Appendix	68 ,,	21 ,,
	724	471

The Transactions only were published in the first issue of bound volumes. A second part, containing the Proceedings of the various Incorporated Societies, is now printed.

During the past year the Governors have had an analytical index prepared, embracing the first eight volumes of the Transactions, which will be issued to members at cost price.

The following volumes are now on hand :—Vol. I., second edition, 540; Vol. II., 3; Vol. III., 8; Vol. IV., 8; Vol. V., 75; Vol. VI., 60; Vol. VII., 200; Vol. VIII, 28; and of Vol. IX., after distribution to members of the Institute, 150 copies.

The Honorary Treasurer's statement of the accounts of the Institute is appended, and shows that there is a balance to the credit of the Institute of £128 9s. 4d.

The progress reports of the various departments under the Manager are also attached.

The library of the Institute has received upwards of 400 volumes by gift during the past year.

James Hector, Manager.

Approved by the Board,

Normanby, President.

29th August, 1877.

MUSEUM.

From the 9th July, 1876, to the present date, 14,500 visitors have entered their names in the book kept in the Museum-hall for that purpose.

There have been 41,159 specimens received into the Museum during 1876-77, 12,159 of which are specimens collected by officers of the Geological Survey Staff.

Herbarium.—The Herbarium has undergone little change since last report; specimens of several local plants have been added by the department, and a collection containing 40 specimens of South Island species has been presented by Captain Campbell-Walker, of the Forest Department, through Mr. T. Kirk.

The presentation, referred to in last report, by the Trustees of the British Museum, arrived during the year in good condition, containing about 28,000 species of European and other plants, but, owing to the want of a suitable place where they can be conveniently referred to, they still remain unpacked.

In connection with the Herbarium Department, a collection of seeds and products, including a large number of pine cones, have been arranged in the north gallery of the Museum, classified in their natural orders and named.

During the year about 50 plates have been lithographed, including the illustrations for Vol. IX. of the Transactions of the New Zealand Institute. Sixty maps and sections have been prepared for the Geological Survey Reports; and the first part of a descriptive work on the Grasses of New Zealand, containing 10 folio plates and letter-press, has been prepared by Mr. John Buchanan, F.L.S., Botanist and Draughtsman to the Geological Survey Department.

Natural History Collections.—The show-cases ordered in London, and those received from the Philadelphia Exhibition, have now been placed in the Museum, and additional accommodation for the display of specimens has been gained by the erection of wall cases round the whole extent of the gallery. The contents of the Museum are now set out on a general plan, although the minute arrangement and cataloguing of the specimens is far from complete. It is intended that the central part of the hall should be devoted to general typical and foreign collections; the north wing to the illustration of the natural history of New Zealand, zoology on the ground floor, and botany in the gallery; while the whole of the south wing is devoted to the collections made in the course of the geological survey of the colony.

A new edition of the Catalogue of the Museum, which will be framed on the complete prospective arrangement, is in preparation.

Mammalia.—No important addition has been made to this section of the collections, only 84 new specimens having been received, from the Smithsonian Institute, U.S. of America. A considerable number of skins and skeletons received from England, and included in last year's return, are still unmounted.

The preparations of the Cetacea have been examined and rearranged, and several large skeletons mounted, among them is that of the great rorqual *(Sibbaldius)*, the goose-beak whale *(Berardius)*, the black-fish *(Globicephalus)*, and the cow-fish *(Tursio)*.

Birds.—235 skins have been received during the year, the largest addition being a collection of 84 species obtained from the Cambridge Museum as an exchange. The number of birds mounted and placed on exhibition during the year is 400. The extensive collection of birds-eggs has received an addition of 65 specimens, and a selection from it has been classified and arranged in the Museum cases.

Fishes.—Convenient shelves have been erected for receiving the alcoholic preparations, and cases prepared for the stuffed specimens, but none of the recent additions to this class, which comprise a very extensive selection of European and American forms, have yet been removed from the tanks in which they were received.

The New Zealand collection has received several interesting additions, and now contains nearly all the known species.

The "Descriptive Catalogue of the New Zealand Fishes," of which an edition of 1,000 copies was published in 1872, is now out of print, and a new and revised edition is in preparation.

Invertebrata.—The publication by the department since last report of the "Descriptive Catalogue of the Crustacea," by J. E. Miers, F.L.S., has enabled the collection of this class to be classified and exhibited, but it is very imperfect compared with the number of specimens attributed to the New Zealand waters.

The Mollusca have been largely added to, chiefly by foreign collections and by alcoholic preparations of the New Zealand species, a series of which it is intended to collect for purposes of study.

The collection of Insects, both New Zealand and exotic forms, is steadily increasing, and arrangements are being made for the publication of catalogues which will embody recent researches on this subject, as at present several eminent naturalists in England are engaged in classifying the different orders of New Zealand insects, and publishing the results in scientific periodicals.

Ethnological.—Under this heading there are 187 specimens entered, being chiefly a collection of celts and other stone implements and weapons

presented by the Trustees of the British Museum, and by the Copenhagen Museum through Captain Rowan.

Minerals.—620 specimens have been added, which number includes a large series obtained in exchange from the British Museum, and selected by direction of Professor J. Storey Maskelyne, F.R.S., in order to make as complete as possible the typical collection, which now contains representatives of every important mineral species. A valuable series, comprising 109 species of ores and associated minerals from the Californian mining region, was received from Mr. H. G. Hanks, which, with the large collection of specimens brought by the Director from the Colorado and Utah regions, affords a very complete illustration of the metalliferous deposits of the Western States.

Palæontology.—Among the foreign collections in this section is a valuable donation from Mr. James Brogden, of a series of the Saurians from Lyme Regis, and the associated Triassic fossils.

For the purpose of comparison, casts of 300 of the best fossil specimens in the European and American Museums were obtained through Professor H. A. Ward.

Geological Survey Collections.—During the present year a special examination has been made of the fossiliferous beds of the Waikato Heads, with a view of determining their age and tracing their extent. A considerable collection of fossils was made from the locality, but the number of distinct forms obtained is small.

An important collection was made from certain blue clay marls occurring at the mouth of the Waikauau Creek, about fourteen miles south of the Waikato Heads, as an upper part of the grey marls not yet detected elsewhere, and which will be referred to as the "Cardita Beds," from the abundant occurrence in them of *Cardita planicostata*, a well-marked Lower Eocene fossil in Europe.

These beds had formerly been classified as the equivalents of the Waitemata beds as developed at Mercer, but the collections now obtained from each of these localities, in addition to stratigraphical evidence, make the separation of these two necessary, the Mercer beds belonging to the chalk marls.

In the Oamaru District six very important collections have been made, in addition to several smaller ones, and the evidence gained renders it necessary to readjust the classification of the beds adopted by Captain Hutton in his "Geology of Otago," his Trelissic group being in part the same as his Pareora group; while, on the other hand, many localities considered by him to belong to his Pareora formation, to his Trelissic formation, and the whole of his Ototara group, will, from the fossils, have to be

distributed from the horizon of the greensands and Saurian beds, immediately overlying the coal up to the grey marls, that closes the cretaceo-tertiary series in this district.

Collections have also been made from many localities in the interior in the district between the Manawatu Gorge and Napier, and much valuable information gained for the proper arrangement of the beds of tertiary age. The results obtained, which will be found in the Geological Survey Reports for the current year, show that the Scinde Island shell limestones and underlying fossiliferous sands and gravels belong to the horizon of the "tufaceous clays and lignitiferous deposits" of newer pliocene age (*see* Reference to Geological Map, 1878), while the Te Aute and Manawatu Gorge limestones represent the Wanganui series; the Taipos or Hawke Bay series of the map being the equivalent of the Awamoa or Pareora beds, which form the base of the Kanieri series in the South Island. There is, therefore, no stratigraphical evidence of the existence of the Ahuriri formation as proposed by Capt. Hutton, so that his later views on the subject, published in the Transactions of the New Zealand Institute (Vol. IX., page 590), are confirmed so far as to exclude that term from future geological classifications.

From Whangarei, collections were also made from the beds overlying the coal, correlating these with the island sandstone horizon of the West Coast. The occurrence of a second or lower limestone was also traced here, replacing the coal in certain localities.

An examination of the country was made between Opotiki and the East Cape, but the impracticable character of the country precluded the forwarding of collections from there. The work has gone to connect the geological structure of this block of country with that previously surveyed between Poverty Bay and the East Cape.

At the present time all the collections of fossils have been worked out and the genera roughly determined, the further work of classifying these for comparison and description being now in progress.

The following general Reports have been printed during the past year, and will be shortly ready for issue:—

Progress Report 1873-74, 164 pp., 15 plates and maps *
,, 1874-76, 191 pp., 16 ,,
,, 1876-77, 157 pp., 38 ,,

METEOROLOGY.

The stations at which observations are made are fourteen in number—viz., Mongonui, Auckland, Taranaki, Napier, Wanganui, Wellington, Nelson, Cape Campbell, Christchurch, Bealey, Hokitika, Dunedin, Queenstown, and Wallacetown.

* Partly published and distributed in 1874.

The monthly returns from these stations are forwarded to the Head Office, and an abstract of the whole prepared each month for publication in the *New Zealand Gazette*. The biennial Report for 1873–74 has been issued in the pamphlet form, and the same Report for 1875–76 is being prepared. The Results of Meteorological Observations taken at all the Stations in New Zealand, for 1876, have been printed, and incorporated with the Registrar General's Statistics for that year.

A monthly report is also furnished of the climate at six of the principal stations, for publication with the monthly vital statistics. A return, giving the daily meteorological readings, with averages and remarks, for the Head Office at Wellington, is printed monthly in the newspapers. The usual abstract of the climate of New Zealand for 1876 has been supplied for Vol. IX. of the Transactions of the New Zealand Institute.

Astronomical.—Time Ball Observatory.

The Observatory is in good order, the astronomical clock being now in an excellent state of adjustment, with a steady rate. All the other instruments are in good condition. Rating time is given to the shipping by the starting clock and time-ball at least once a week at Wellington, due notice being given in the morning papers. Mean time is also transmitted to Lyttelton; but, as it is not by the automatic clock, the same accuracy cannot be obtained.

The observations are, as hitherto, chiefly taken by the Ven. Archdeacon Stock, B.A., assisted by Mr. J. Kebbell, who is a most skilful and enthusiastic amateur.

The only extra work at the Observatory during the past year was the search for the supposed intra-mercurial planet, which was made at the request of the Astronomer Royal, and in which I had the cordial assistance of Mr. W. T. L. Travers, F.L.S., and Mr. J. Newton Coleridge, C.E., whose experience, as amateur photographers, was of great service on such an occasion.

Laboratory.

The following is a summary of analyses performed in the Colonial Laboratory during the past year:—

	Analyses.
1. Coals	22
2. Rocks and Minerals	22
3. Metals and Ores	38
4. Examination for Gold and Silver	31
5. Waters	23
6. Miscellaneous	32
Total	168

A full account of these analyses will be found in the Annual Report on the work performed in the Laboratory, published as a separate report.

JAMES HECTOR, Manager.

ACCOUNTS OF THE NEW ZEALAND INSTITUTE FOR 1876-77.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance in hand, 19th September, 1876	218	4	4	Expenses of Printing Volume IX.	600	13	11
Vote for 1876-77	500	0	0	Expenses on account of Index	28	0	0
Contribution from Wellington Philosophical Society ..	31	10	0	Miscellaneous Items ..	13	6	1
Sale of Volumes	15	15	0	Balance	123	9	4
	£765	9	4		£765	9	4

ARTHUR STOCK, Hon. Treasurer.

28th August, 1877.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting. 21*st July*, 1877.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

New Members.—Charles O'Neill, C.E.; J. P. Maxwell, A.I.C.E.; Ebenezer Fox; Edward Thorley Noakes; H. S. Mackellar; C. P. Knorpp, A.I.C.E.; the Hon. W. D. H. Baillie, M.L.C.

1. The President, in opening the proceedings, apologized for the absence of Dr. Buller, who, in consequence of engagements in Napier, was unable to be present at that meeting. He then proceeded to say that in bringing under the notice of the meeting the papers which were to be read that evening, he would make a few remarks as to the progress made by the society during the past year. Having learned during the early part of the week that Dr. Buller would be unable to attend, he had entertained hopes that he should be able to put together a few notes of what had been accomplished by the society during that period; but unfortunately engagements of a professional character prevented him from doing that which he had desired to do, and he had to trust to a few meagre notes of what had been done during the last session, not only by this society, but by all the Incorporated Societies in New Zealand. He then entered on the subjects of his address, first referring to the very considerable assistance obtained through the labours of the Geological Department for ascertaining the mineral resources of the colony, and then alluding to the importance of the discoveries made in reference to the races which had inhabited New Zealand since the time when any record could be obtained of the country. A work on the subject had been recently published, a copy of which would be a valuable addition to the library of the Institute. He next referred to papers contributed by different members of the society on a variety of subjects, and in his concluding remarks said he was glad to observe a growing interest in scientific examinations. He then briefly referred to the papers to be read that evening, which were of a very interesting character.

2. On the motion of the Hon. Mr. Mantell, seconded by Capt. Edwin, a vote of thanks was given to Dr. Buller for the able manner in which he presided over the meetings of the society as president during the past two years; and also to Mr. Travers for the address he had just given in opening the meeting.

3. "On Gold in the Wellington Provincial District," by J. C. Crawford, F.G.S. (*Transactions*, p. 477.)

The Hon. Mr. Mantell, who read this paper for the author, said he would like some explanation regarding the presence of sulphate of iron.

Dr. Hector stated that there must have been some mistake, probably iron bi-sulphide was meant. He reminded the society that a great deal had been done in prospecting the country referred to by Mr. Crawford, and that in 1869 he (Dr. Hector) had communicated to the society the results obtained. Eighteen analyses had been made of quartz

specimens from reefs in the district; of these only six had proved auriferous, varying from mere traces up to 13dwts. per ton of gold, the richest being from Wainuiomata, the same locality from which Mr. Crawford's specimen had come. In his former communication he had warned prospectors against the solid quartz reefs which traverse the sandstones and slate, as the gold at Makara and Terawiti appears to occur in jointed sandstones chiefly as dendritic films.

4. "Notice regarding the Occurrence of the Tidal Wave of 11th May, 1877," by J. F. Martin, of the Bay of Islands; communicated by Capt. R. A. Edwin, R.N.

ABSTRACT.

Patrick McAlister, of Manowara, in the Bay of Islands, tells me that he and his brother loaded a boat last night (Thursday, 10th May) and pulled her up on the bank of a creek for safety. On going to her at five o'clock this morning the creek and a mud-flat that extends some distance from the shore was found to be quite dry; the tide, however, was a long distance above high water-mark. While waiting they heard a loud noise as of thunder and saw a large wave approaching, whereupon they ran towards the house calling upon the inmates to leave. The wave, however, reached the house as soon as they did, and surrounded it to the depth of about a foot. After this the water quickly subsided.

No such event had been noticed at Russell, but Captain Farquhar, of the s.s. "Iona," said he had a similar experience this morning, at Waitangi, on the opposite side of this bay. This morning he went ashore, the tide falling at the time. Soon after landing a large wave rushed in, and deposited the boat and a sailor, who had gone to put her afloat, above high water-mark.

Mr. Thomas Joyce, of Pahia, reports extraordinary tides.

About midday I observed the water at the wharf fall over four feet in ten minutes, and in about fifteen minutes afterwards it rose over six feet. The American whaler "Gazelle," at anchor in twenty feet of water, was speedily aground, and soundings showed only twelve feet of water alongside her. Several vessels at anchor were swinging with their bows in opposite directions, while others were revolving in a circle.

There was nothing particular to note at high water, which occurred at 4 p.m., but at 8 p.m. the tide was high again.

Maoris from some of the islands in the bay tell me that at about 5 p.m. the water rose over eight feet in as many minutes. It rushed in several times at intervals of about twenty minutes, and continued rising and falling rapidly until late in the evening.

About the same hour Mr. Ford, of Russell, went across the bay to a place called Wairoa, and while there a huge wave suddenly swept both his boats into a paddock. The water then rose and fell rapidly several times, but not so high as before.

Captain Charles Dane, of the schooner "Elsinore," from the loading ground (Te Wharau), a branch of the bay, says that he noticed the tide ebb and flow seven times during the day.

The general idea is that these disturbances resulted from a very heavy earthquake to the eastward.

The author also records that on Sunday, 23rd July, 1876, at 10 p.m., the tide rose at Russell four feet above high-water mark within twenty minutes, following a heavy N.E. gale.

The President said he had observed this occurrence in Wellington harbour, and that he believed Dr. Hector had taken observations of the rise and fall. Some years ago a

similar wave was observed in New Zealand, after which we had news of an earthquake in America, and no doubt the wave on the 11th of last May was due to a like cause.

Dr. Hector said the tidal disturbance on the 11th of May had been observed on every part of the New Zealand coast, and also in Australia in the same manner; but not so intensely as the waves of August, 1868. The origin of the waves on that occasion was clearly traced to a great volcanic disturbance near the west coast of South America, and in this instance a violent convulsion has also been reported from that quarter as having occurred on the 10th of May. We have not the full particulars yet, but if this date is correct the wave felt on our coast must have been due to a still earlier shock, perhaps in some other place, as it was first noticed at 5 a.m. on the 11th, corresponding to 1 p.m. of the 10th on the South American coast. From this date must be subtracted about seventeen hours for the time of the transmission of the wave across the Pacific Ocean, which would require that the shock should have taken place about 8 p.m. on the 9th. This tends to confirm the belief that there is a periodicity in earthquakes, and that they occur independently at distant localities at nearly the same time. He observed that a writer in the last received number of *Nature* notices this coincidence in reporting a sharp earthquake at Comrie, in Scotland, on the 11th of May. At Napier, where the engineer of the harbour works, Mr. Weber, makes exact observations, the tides were disturbed from the 11th to the 19th. The position of Napier renders it peculiarly sensitive to oceanic oscillations. Thus, on the 1st of May the highest tide ever experienced in Napier washed over the shingle spit, and damaged the rails in front of the Court-house. This phenomenon was, however, local, and was attributed only to a long continuance of south-east wind. He called attention to a recent paper by Mr. Russell, the Government Astronomer at Sydney, which states that the slightest earth-shocks felt in New Zealand are nearly always recorded on the tide-gauges in Sydney and Newcastle, and are most unaccountably coincident with abnormal readings of one of the thermometers in the Observatory.* If we had well-placed tide-gauges on the New Zealand coasts it is probable the most interesting results would be obtained. Every addition to the observed facts bearing on this subject would be valuable. The investigation of earthquakes would be similar to that of the influence of sun spots recently examined by Professor Balfour Stewart, in so far that the release of prodigious latent energies might depend on very obscure and trivial exciting causes.

Mr. Carruthers said he did not consider it necessary to suppose that seventeen hours must elapse before a tidal wave, due to the same cause as the South American earthquake, would reach New Zealand. He did not think the earthquake caused the wave, but that both were due to the same cause. He thought earthquakes were locally intensified exhibitions of a great deep-seated movement of the floor of the ocean, and that, if the floor were not in movement, an earthquake, however violent, would be unable to propagate a wave for such a distance as from America to New Zealand. The intensified action which so often shows itself in a part of South America he thought was due largely to the great bend made in the line of elevation of the Andes at this point, which had the effect of converting a deep-seated movement of the earth's crust into a violent crushing of the surface.

Dr. Hector explained that the period of seventeen hours for the transmission of a wave across the Pacific Ocean was derived from observation in 1868, when the commotion of the sea extended not only to New Zealand and Australia, but to Japan, the Sandwich Islands, and the Cape of Good Hope. He agreed that earthquakes were wide-

* Trans. R. Soc. N.S.W., 1876, p. 37.

spread phenomena locally intensified, but it is the strong local convulsion that originates the oceanic waves. Such waves could not keep pace with a tremour propagated through the solid floor of the ocean, which travels at six times greater speed. The ocean wave once generated would take its own time.

Dr. Newman did not think we had yet sufficient data to decide on the subject. The depth of the ocean should be considered. He could not agree with Mr. Carruthers that earthquakes extended over so large an extent of the ocean bed.

The President said that the works of Darwin, Humboldt, and Mallett, on this subject, would be found interesting. He agreed with Dr. Hector that we must look for reasons outside our globe for such disturbances, such as sun-spots, influence of the moon, etc.

Before the close of the meeting, Dr. Hector drew attention to several exhibits on the table, more especially to an albino of the New Zealand crow (*Glaucopis wilsoni*), and to a tui with brown plumage. A fine series of Crustacea from the Californian coast, and a selection of the more interesting fossils obtained during the past year by the Geological Department, were also exhibited.

SECOND MEETING. *4th August*, 1877.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

New Members.—Joseph Joseph, Gordon Saxby.

1. Dr. Hector drew attention to several interesting additions to the Museum, which were arranged on the table. Among the most important were a handsome bird from New Guinea, the *Goura victoriæ*; a collection of valuable old etchings presented by Mr. William Swainson; a petition to the Queen, dated 1840, about which the Hon. Mr. Mantell gave some interesting information; a collection of New Zealand plants from the Forests Department, which Mr. Kirk described; iron-stones and fire-clays from Miranda Redoubt, remarked upon by Mr. S. H. Cox; a specimen of patent building stone, two live kakapos from Preservation Inlet, and some splendid specimens of copper ore, discovered by Mr. Docherty in Dusky Bay, which Dr. Hector spoke very highly of as a form of copper ore that frequently contained nickel.

2. Mr. Kirk called attention to a log of black maire, a species of olive, sent by Mr. Elliotte, of the Pakuratahi, which, on account of its great hardness, is much used for blocks and cogs in machinery, which fact was borne out by several present.

Mr. Nicholl stated that he had used it in Nelson instead of brass in constructing water-wheels.

The Hon. Mr. Mantell stated that Mr. J. Kebbell had pronounced it superior, for turning purposes, to boxwood; he had himself in the old days engraved a heading for the *New Zealand Spectator* out of this wood.

3. The President read a letter from a friend in Peru, which confirmed Dr. Hector's estimate, given at last meeting, of 8 p.m. on 9th May as the time when the earthquake occurred at that place, in connection with the tidal wave which was observed in New Zealand on the 11th May last.

4. Dr. Hector read an interesting letter from Dr. Berggren, of Lund, regarding his description of certain New Zealand plants, and giving a short account of his discoveries relative to the development of the *Azolla rubra*.

The President remarked that this plant grew very abundantly, and was a troublesome plant in watercourses throughout the colony.

5. "On the Reciprocity of the Seasons with those of the Northern Hemisphere," by S. G. Rawson; communicated by Capt. Edwin.

ABSTRACT.

The author said that for eight or ten years past he had observed that the character of the seasons in the North Island corresponded with that of the previous season in England, so that a wet summer in England was followed up by a wet one here, and a fine harvest there was always succeeded by a good one here. This agreement of the seasons with those of England appeared to be so certain that farmers in New Zealand might learn when to sow early and when late wheat, and when to refrain altogether from putting in wheat. The author, having this belief, had foretold an unusually dry and hot summer for New Zealand.

Mr. Carruthers thought that even in New Zealand the seasons did not agree.

Dr. Hector said it would be necessary to fix upon the one place for comparison, as seasons were not uniform, a moist season on the East Coast being frequently a dry season on the West Coast.

Dr. Newman considered that the seasons were affected all over the world by sun-spots.

6. "On the Occurrence of Gold in the Mackenzie Country, Canterbury," by Alexander McKay, of the Geological Survey Department. (*Transactions*, p. 481.)

Dr. Hector added some interesting information regarding the occurrence of gold generally in that district, and pointed out that Mr. McKay's observation, that the gold and associated quartz were found only in the last-formed moraines and alluviums, confirmed his theory that the retirement of the glaciers was chiefly due to the erosion of the mountains.

7. "Some Remarks on the Plant called Prickly Comfrey (*Symphytum asperrimum*)," by J. C. Crawford, F.G.S.

ABSTRACT.

The author mentions that the climate of New Zealand is more favourable to the growth of forage plants than those of Great Britain and Australia. The stimulus of necessity, however, produces better farming in countries which have greater difficulties of soil and climate to contend with than in those where the conditions of growth are more favourable; and he gives Scotland as an instance of the stimulus of necessity acting to produce a higher class of farming than in its more favoured neighbour England; so the more severe climate of the South Island, and the necessity therefore of providing winter food for cattle, stimulates to better agriculture than in the North Island, where the climate is milder. The author, having taken a glance at the fodder plants generally grown, draws attention to the prickly comfrey (*Symphytum asperrimum*), a perennial herbaceous plant belonging to the family of *Anchusa*, or borage plant. This valuable plant was introduced to Europe from the Caucasus of late years, and its pretensions are that it is easy of culture, that it lasts for ever, that it is well relished by stock, which thrive well upon it, that its medicinal effect is good, and that it far surpasses all other forage plants in the quantity of produce. The author then proceeds to quote largely from the Country Gentleman's Magazine of April, 1875, and from a pamphlet by Mr. A. T. Holroyd, an old Wellington settler. From these it appears that this grass has been

successfully cultivated in Ireland and in parts of England for some years—that it is much relished by horses, etc., and yields, according to Mr. Christy, as much as 80–120 tons to the acre. It will grow upon dry soil even when poor and unsheltered. It must, however, be kept free from weeds, and the ground must be well manured. This plant is not to be confounded with *Symphytum officinale*, the common comfrey of Britain, which is quite worthless. In addition to its other recommendations it is said to be preventive of fever, lung, and foot and mouth diseases. Mr. Holroyd's pamphlet is published by F. Cunningham and Co., of Sydney, and Messrs T. Christy and Co., of Fenchurch Street, London, will supply plants.

Dr. Hector said that Mr. Ludlam, from enquiries in England, had thought it desirable to send out root cuttings of this plant, which were on their way.

8. "Notes on three dried Specimens of Matai (*Podocarpus spicata*)," by T. Kirk, F.L.S. (*Transactions*, p. 417.)

These specimens were collected by Mr. Seymour, M.H.R., and the paper went to show that the author did not consider there was yet evidence to prove more than one kind of this tree. Although different in appearance, they were the same.

Mr. Seymour still thought there must be two kinds of this timber, on account of difference in value, and he would endeavour to obtain further evidence to prove this. He did not think that age alone could cause the difference, as supposed by Mr. Kirk.

A long discussion ensued, in which Mr. Carruthers, Mr. Higginson, Mr. Coleman Phillips, and others took part, on the relative value of the white and yellow pine, most of the speakers bearing testimony to the superiority of the yellow over the white; Mr. Kirk, however, believing that they were only different forms of the same tree, there being no botanical difference by which they could be separated.

Dr. Hector hoped that they would soon have Mr. Kirk's promised paper on these pines, and remarked that this discussion only showed how necessary it was to abandon all popular names in favour of scientific terms founded on the observed characters of these trees.

Third Meeting. 18*th August*, 1877.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

New Members.—B. T. Chaytor, Robert Govett.

1. "Remarks as to the Cause of the Warmer Climate which existed in high Northern Latitudes during former Geological Periods," by W. T. L. Travers, F.L.S. (*Transactions*, p. 459.)

ABSTRACT.

* This paper was a review of the progress recently made in our knowledge of the subject, and especially the bearing of Nasmyth and Carpenter's examination of the moon's surface, and the work by Mattieu Williams on the "Fuel of the Sun." The author

* The author desires it to be stated that, since reading the above paper, he has found that somewhat analogous views, with reference to the cause of the former warmer climate in Arctic latitudes, had been expressed by Ernst Haeckel.—*Vide* "History of Creation," vol. I., chap. xiii.

adopted the view that the gradual condensation of water on the earth's surface consequent on the loss of its original cosmical heat, had produced the succession of phenomena resulting in the present distribution of life. That in consequence of the cooling having taken place first in the polar regions, it was there that the higher and latest-formed organisms must have first appeared. He adduced as proof of this the existence of fossilized vegetation within the arctic regions which had almost a tropical character, and other evidence that during successive geological epochs the changing character of the fauna and flora in other regions showed that the climate had gradually become more and more temperate.

Dr. Hector would only speak as regards the geological aspect of the author's paper. The fact that the oldest rocks we know are either hydrated or formed by the action of water as sediments, proved that our geological records did not carry us back to a time when very high temperature prevailed. It was only therefore necessary to enquire into the evidence of a minute secular cooling afforded by the succession and distribution of animals and plants during former epochs. He considered this evidence very unsatisfactory, and not leading in the direction the author required. The former existence of temperate plants in high latitudes took place at a very late period in the earth's history, and long after some temperate regions had possessed a fauna and flora similar to that at the present time. There had in fact been several repetitions of the abnormal distribution of animals and plants on which the author founded his argument, and consequently of the climate; so that these changes could hardly be referred to the progressive cooling of the globe as a whole. The inferences made had chiefly been drawn from late tertiary strata; but in the case of New Zealand there was evidence that the same type of vegetation had survived since the early part of the cretaceous era, a period twenty times as great as that which had elapsed since the supposed sub-tropical fauna inhabited Central Europe, or the temperate flora flourished in the arctic regions. From this it was surely to be argued that the cause had not been one of universal operation. Concerning the former arctic flora the real difficulty was not the question of temperature so much as the absence of light in that region for six months of the year, if all other conditions of the earth remained as at present, except a general higher surface temperature. Many speculations had been put forward on this subject; one of the latest, by John Evans, was that the earth was solid, with an oxydized crust, separated from the central nucleus by a viscous layer of unequal thickness, in which chemical combination, or, as it may be called, the "rusting process," was still active. The elevation of mountain masses by the fracture of the crust would act like weights on a gyroscope and lead to a gradual displacement of the outer crust with reference to the axis of rotation of the interior bulk of the earth, which astronomers required us to believe to be immovable. He also pointed to recent researches of Professor Duncan regarding reef-building corals, which at the present time are confined to a narrow equatorial belt, but in eocene times that belt appears to have had a distribution oblique to the present equator. If this were established it would offer a still greater difficulty in the way of accepting the view that the changes in distribution of climate were due to the secular cooling of the earth as a prime cause.

Dr. Newman did not think there was any evidence of water in interstellar space. From spectroscopic-observations and the analyses of meteorites, it had only been shown that hydrogen existed. He thought that the order in which metallic elements were found in an oxydised state in the earth's crust was in favour of a theory of gradual cooling.

Mr. Kirk agreed with Dr. Hector regarding the difficulty in understanding how such plants as *Magnolia* and the tulip tree could not only exist but perfect their flowers and fruit where light was absent for six months of the year. The absence also of all forms of low plant-life, which might naturally be expected under such circumstances, required explanation.

Mr. Cox thought the author had overlooked the evidence of former glacial periods at successive intervals as far back as the Devonian epoch, with intervening periods, during which warmer conditions prevailed.

Mr. Martin Chapman said that, unless the oldest formations were proved to be sedimentary, the presence of water in them would prove nothing, as water must infiltrate the deepest rock we can reach. He thought the temperature at which plant-life could exist had been understated, from his having collected organisms in the hot springs in Hecla (Iceland), which had a very high temperature.

Mr. Carruthers thought that the paper was so important that its discussion should have been deferred. He thought it not yet proved that there was a central heat, and certainly not that it could influence climate. The argument derived from increase of temperature with depth in the earth's crust only proved a modified form of volcanic action—in some places greater than in others. The greatest depths to which we reached were the bottoms of the oceans, and there we found no evidence of a higher temperature, but the reverse. In open oceans it might be argued that this was due to the removal of the heat by currents; but in the case of the Mediterranean, and also in Loch Ness, which are deep holes without an outlet, excepting for the surface water, the temperature at the bottom is the same as the average winter temperature of the air at the surface. In the nebular theory heat had always been assumed as being the expanding force which was gradually lost; but this was not proved. Cosmical dust is not kept apart by heat, but by the continuous motion of the particles. He thought the balance of evidence was against the theory of central heat. If the earth had once been hotter it would have become smaller in cooling, and its velocity of rotation would have increased; but this was contrary to fact, as the rotation had been retarded by about three hours since exact observations were first made. With regard to what had been said about the thickness of the earth's crust, the existence of tides proved that it must be so great as to be absolutely rigid. He considered it quite possible for plants to live in darkness if they remained dormant, like geraniums which are placed in a dark cellar during the winter.

Mr. Travers, in reply, said he had not advanced any theory of his own, but merely wished to direct attention to views that were gaining ground. He thought that when geologists had studied the works to which he had referred, they would very much alter their present opinions on the subject.

Owing to the late hour at which the discussion terminated, several papers were held over for next meeting.

Fourth Meeting. 1st *September*, 1877.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

New Members.—A. T. Maginnity, J. J. Cherrett.

Attention was drawn to several additions to the library, viz., publications on the geological survey of the United States and other works received through the Smithsonian

Institute, further works on results of the Novara expedition, and survey and weather reports from the Royal Society of New South Wales.

1. "On a peculiar Method of Arrow Propulsion as observed amongst the Maoris," by Coleman Phillips. (*Transactions*, p. 97.)

The author illustrated the method described by a model.

The President, in inviting discussion on this paper, regretted that Mr. White had not been able to attend the meeting, as he felt sure that that gentleman would have afforded interesting information on the subject. Mr. White hoped to be able to deposit a large collection of such weapons in the Museum.

Mr. Carruthers said the absence of the bow among the Maoris was certainly curious; but the same might be said of the Malay race, who were familiar with the smelting of iron, while the Maoris knew nothing of it. It was proof that in the migration of the Maori race certain arts were lost.

Mr. Grace, who had been in New Zealand from his youth, said that the bow and arrow was a common weapon in the interior with the Maori youths, and he believed that it was originally used by the natives. It was, however, found by them to be an inconvenient weapon in the bush, and hence their reason for adopting the plan mentioned by Mr. Phillips. The Maoris scarcely ever threw a spear by hand; they used the string twisted round a fork in the spear. The notch mentioned by the author was new to him.

2. "On Grasses," by S. M. Curl, M.D. (*Transactions*, p. 345.)

This was a continuation of a paper read before the Society last year by the same author.*

The Hon. Mr. Holmes considered this a most important paper, as on the proper cultivation of grasses would depend in a great measure the future prosperity of the colony. At the present time a very small variety were grown, and not sufficient to last throughout the year for pasture; the principal grasses in use being the ryegrass (*Lolium perenne*), cocksfoot (*Dactylis glomerata*), timothy (*Phleum pratense*), Dutch clover (*Trifolium repens*), red clover (*Trifolium pratense*), and the cow-grass (*Trifolium medium*). Of the latter the cow-grass was the most valuable. He believed that some of those mentioned by Dr. Curl were among the best that could be introduced. He had himself two consignments on their way to New Zealand, of about twenty-two different varieties, that he believed would be of peculiar value to this country. If they proved successful, it would make a vast improvement in the permanent pasture of the colony. With regard to ergot, he did not consider it peculiar to the ryegrass, nor did its presence indicate any falling off in the quality of the grass, and there is no reason why the grass should fail in consequence of it. As an instance that nature had made provision for a great variety, it might be mentioned that a square foot of ground that had not been broken up for years, was found on examination to contain seventeen different varieties.

The President stated that the Canterbury Society had offered a prize for information regarding ergot. But it seemed strange that the valuable information on this subject afforded by Dr. Berggren† should have been entirely overlooked. He thought that by good draining ergot might be kept down; excessive moisture was favourable to it. He considered Dr. Curl's paper of great importance.

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* Trans. N.Z. Inst., IX., 531. † Trans. N.Z. Inst., VII., 488.

3. "A System of Weights and Measures," by J. Carruthers, M. Inst. C.E. (*Transactions*, p. 155.)

The author proposed to change the radix of counting from 10 to 16, and to adopt the latter number as the radix for all weights and measures.

Dr. Newman did not altogether object to the decimal system; it was most useful in some cases. He considered 12 a better number than 16.

It was resolved that the discussion of this paper should be postponed in order that members might have an opportunity of studying it.

4. "Further Remarks upon Prickly Comfrey, with Description of a mode of storing it and other Forage Plants," by J. C. Crawford, F.G.S.

ABSTRACT.

In continuation of his former paper on *Symphytum asperrimum*,* the author quotes largely from an article in the "Gentleman's Magazine" for March, 1877. From this it appears that the prickly comfrey contains an unusually large percentage of nitrogen, and is the earliest spring crop on the farm. When green food becomes abundant the prickly comfrey should be regularly cut and stored in tanks or pits after the Algerian custom, for use during droughts or winter. The successful experiments of several French gentlemen are recorded. The pits are of stone or brick, in one case being 36 feet long by 6 feet in breadth and width (but the deeper the pit the better is the forage owing to the pressure) and a pit of that size will hold 40 tons of green maize mixed with about one-fifth of its weight of rye-straw chaff. The fodder is trodden down in the pit, and, after the top layer is sprinkled with salt, it is covered with straw and planks weighted down. It is necessary to examine the pits every day at first or the settling of the fodder may cause cracks in the straw roof and admit the air. One gentleman builds his pits on the slope of a hill to facilitate the escape of moisture. Another has found the sour keep excellent food for oxen for five years past. In England too much salt was often employed, which retarded fermentation. Opinions differ as to the degree of ripeness the crop should be allowed to attain before being cut, but the leaves and flowers are never allowed to become so dry as to drop off during transport. Crops cut in wet weather in 1876 and stored after being quickly cut up were found quite equal to that put up in dry weather. It requires to remain in the pit at least six weeks before being consumed, and some caution is necessary in feeding with it, as the presence of lactic acid in excess may cause diarrhœa. The author says that soils generally in New Zealand require phosphate of lime, and quotes an English authority, who advised, with regard to an Auckland soil, the use of half-inch bones to supply phosphate, and the ploughing in of some leguminous plant to supply nitrogen. The author concludes by saying that land for pasture should be laid down rich, as few crops being taken off beforehand as possible, giving an illustration of successful practice in Northumberland, and he thinks that the growth of good forage plants will help towards this, because from their consumption manure would be produced.

5. "On the Improvement of Wellington Harbour in providing additional Wharf Accommodation," by J. C. Crawford, F.G.S.

ABSTRACT.

The author says the chief wind against which shelter is required is the wind varying from N. to W.N.W., commonly called the north-west wind. In the original reclamation

* *Ante*, p. 523.

as far as Mills' Foundry, this was carefully considered, and the author considers the line then taken to have been the best that could be adopted. The wharf also was run out at an acute angle to the breastwork for the same reason. The author considers that any future improvements should be by building wharves parallel to the present wharf, thus increasing the amount of smooth water. Capt. Halliday proposes to make wharves at right angles to the Queen's Wharf, and the author is not prepared to say that this would not be an improvement on his plan. He condemns the proposal to reclaim land from Mills' Foundry to the middle T of the wharf, as a lee-shore would thus be made, against which it would be dangerous for ships to lie, and consequently it will be found necessary to construct another work to the northward to protect it. In the event of reclamation at the Te Aro end of the town, the author thinks it should be borne in mind that it is practically a wet dock at present, where small vessels can lie safely, and that it is more important to give additional smooth water for vessels than more land for stores and offices.

Fifth Meeting. 22*nd September*, 1877.

J. Carruthers, M. Inst. C.E., Vice-president, in the chair.

New Members.—William Fitzgerald, A. W. F. Halcombe, H. F. Rawson.

1. "Notes on the Physiology and Anatomy of the Tuatara (*Sphenodon güntheri*)," by A. K. Newman, M.B., M.R.C.P. (*Transactions*, p. 222.)

The author did not confine his remarks to his written paper, which is of a technical nature but gave a popular account of reptiles generally, showing their relations to other forms. He exhibited a beautifully-prepared skeleton, lent by the Hon. Mr. Mantell from the Museum, and also a live specimen.

Dr. Buller was pleased that the author had given his remarks in so popular a form, and he had listened to them with great interest. He had himself at a former meeting given a description of this lizard. Dr. Günther had published an elaborate description of *Sphenodon punctatum*, and now, with Dr. Newman's valuable paper on *S. güntheri*, we could compare the anatomy of both. He hoped to see the whole of Dr. Newman's paper in the next volume of Transactions. He intended shortly to read a paper on a third variety of this lizard which he thought might prove a distinct species.*

The author, in answer to a question by Mr. Buchanan regarding the growth of new bones in lizards' tails when accidentally broken off, said that the vertebræ when broken off never grew again, but merely an additional part without bone.

Mr. Carruthers differed from the author regarding the earlier forms of life, which he considered were just as complete and perfect as at present.

2. "On a means of selecting the most durable Timber," by John Buchanan. (*Transactions*, p. 190.)

Mr. Carruthers thought there would be some difficulty in procuring fair standard specimens. He did not altogether agree with the author that the heaviest timbers were the most durable. If cut at the proper season and heart-wood only used, nothing further regarding the selection of our timbers would be needed. He saw no necessity for the

* *Vide ante*, p. 220.

injection of fluids into timber for its protection so long as we can get timber which does not require them. New Zealand timber he thought not well suited for the purpose owing to its density.

3. "On the Disappearance of the Korimako *(Anthornis melanura)* from the North Island," by W. L. Buller, C.M.G., ScD. *(Transactions*, p. 209.)

Mr. Govett asked if the author could explain why the bell-bird was disappearing so rapidly.

The author replied that the Maori theory was that it was being driven away by the introduced bee, which lived on the flowers that this bird liked, but he himself considered that its disappearance was due to the rat. When the rat is kept down by the hawk birds do not disappear.

Mr. Braithwaite considered that the wild cat had something to do with it.

Mr. Kirk did not think these birds were disappearing so rapidly as the author would lead them to suppose. He had seen them in numbers in Nelson and Westland. They certainly were scarce in some parts of the North Island, but he had met with them frequently on the Great and Little Barrier Islands, and in 1864 and 1865 they were abundant at Omaha, but not so numerous of late. No doubt the rat was their chief enemy.

4. "Notice of the Occurrence of the Shy Albatros *(Diomedea cauta)* in the North Island," by Walter L. Buller, C.M.G., ScD., F.L.S. *(Transactions*, p. 217.)

The author exhibited specimens.

Sixth Meeting. 17*th November*, 1877.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

New Members.—H. S. Fitzherbert, C. A. Baker, Capt. Courtenay Kenny, M.H.R.

Mr. J. C. Crawford was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the "New Zealand Institute Act."

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with statute IV.

1. "On the Formation of detached Shingle Beaches," by John Carruthers, M. Inst. C.E. *(Transactions*, p. 475.)

Mr. Maxwell spoke in approval of the paper, and said the author's views on the subject were new to him.

Mr. Travers said he had learned that Golden Bay had shallowed considerably within the memory of colonists. This may be attributed to the destruction of forests, the denudation of land generally, and to mining operations, which had loosened the earth. It was then carried down by the rivers and deposited in comparatively still waters. He was informed that the bay in places was shallowing so rapidly that where there was at one time ten to twelve feet of water there is now only from four to five.

Mr. Young made some remarks regarding the numerous bar harbours in New Zealand.

Dr. Newman asked how it was that in the case of boulder banks the larger stones were found on the top of the beach and the smaller ones at the bottom. He gave an instance of this, where the larger stones appeared to have been carried a distance of twenty miles, whilst the smaller ones were to be found close to the water.

The author stated that this was easily explained. When an unusually large wave came the big stones were thrown up on the beach, and the ebb flow was not sufficient to take them back, whilst the little stones receded with the waves, and were ground still smaller. Alluding again to the effect rivers had in creating beaches, he stated that Lake Ellesmere was being gradually filled up by the débris brought down by the River Selwyn.

2. "On *Nephrodium pentangularum*," by T. Kirk, F.L.S.

3. "On the New Zealand Species of *Phyllocladus*," by T. Kirk, F.L.S. (*Transactions*, p. 378.)

4. "Notice of a new Variety of Tuatara Lizard (*Sphenodon*) from East Cape Island," by Walter L. Buller, C.M.G., ScD., F.L.S. (*Transactions*, p. 220.)

The author said that Dr. Newman agreed with him that it was probably a new species, though it was just possible that it was an accidental divergence from a kind previously discovered, and not a distinct variety. Still, he was informed by Mr. White that he had seen another exactly similar in the possession of a Maori. Speaking of the lizards in his possession, Dr. Buller stated that they had lived without food for twelve months, and had fattened during that time. However, they had taken to food three or four months ago, but they had not thriven so well since. One of the lizards he found dead on the previous day, and some of the others did not appear in as good health as formerly.

Dr. Newman said there was more interest attaching to this animal than to the moa and others which had created a great deal of talk. It was the last of its race, and its study would, in his opinion, throw a good deal of light upon much that was not now clear, and would extend even to the organization of man, and prove the correctness of theories which had been recently advanced.

5. "Further descriptive Notes of the Huia (*Heteralocha acutirostris*)," by Walter L. Buller, C.M.G., ScD., F.L.S. (*Transactions*, p. 211.)

6. "Further Remarks as to the Cause of the Warmer Climate which existed in high Northern Latitudes during former Geological Epochs, by W. T. L. Travers, M.H.R., F.L.S. (*Transactions*, p. 470.)

Mr. Carruthers differed from the general opinion held as to the internal heat of the earth. It had never been proved that such heat existed. People had simply inferred it from the existence of volcanoes; but it was now placed beyond doubt that volcanoes had no connection with the centre of the earth. As for the belief that mines got hotter as a further depth was reached, that would only be the case in volcanic localities. If a shaft were sunk in a place free from volcanic influences, he believed it would be found that the earth got colder the further they descended, and at twenty or thirty miles it would probably be found that there was a mass of ice.

After a few remarks from Mr. Travers, in reply to Mr. Young as to the eccentricities of the earth's orbit, the discussion closed.

A specimen of wrought iron work was exhibited, representing a *Fuchsia* plant with leaves and flowers, executed by Mr. Birley, of Auckland.

The Hon. Mr. Mantell stated that the same gentleman had also executed other works of a rare nature in iron, and had deposited at the Museum a knife-blade, in the centre of which there was an unburnt straw. The imitation of the fuchsia in flower was a really artistic piece of work, and it was hard to imagine, looking at the perfection of the flower and leaves, that it had been made of such a rigid material as iron. A detached flower with leaves was handed round amongst the audience, the workmanship of which was much admired.

Seventh Meeting. 1st *December*, 1877.

J. Carruthers, M. Inst. C.E., Vice-president, in the chair.

New Member.—F. W. Riemenschneider.

1. "Notes on the Ornithology of New Zealand," by Walter L. Buller, C.M.G., ScD., F.L.S. (*Transactions*, p. 191.)

Specimens of all the species mentioned in the paper were exhibited to the meeting; and among these was a young example of the plundering gull (*Stercorarius parasiticus*), obtained in Wellington harbour in the early part of the present year.

Dr. Hector said that he had listened to the paper with very much interest, and particularly the portion relating to the habits and migrations of the godwit. He was glad that the author, not content with the laurels he had so well earned by the publication of his great work on "The Birds of New Zealand," continued to prosecute his researches and to lay the results before the society in so interesting a manner.

Dr. Newman and Mr. Young took part in the discussion that followed.

Mr. Kirk stated that the knot-bird is found at the Waitemata river at times, which seems to be the limit for many birds—the paradise duck, for instance.

2. "On *Nephrodium decompositum*, Br., and *N. glabellum*, A. Cunn," by T. Kirk, F.L.S. (*Transactions*, p. 898.)

8. "Description of a new Species of *Hymenophyllum*," by T. Kirk, F.L.S. (*Transactions*, p. 894.)

In reply to Dr. Buller, the author stated that this was the nineteenth species of *Hymenophyllum* now discovered in New Zealand.

Mr. Kirk pointed out that *Trichomanes armstrongii* of Baker, which he had collected in the Waimakariri, Arthur's Pass, and near the sea-level at Hokitika, was a true *Hymenophyllum*, the involucre being distinctly two-valved and divided to the base when mature. In some instances the involucres have the tips partially reflexed, resembling those of *H. bivalve*, Swartz.

Plate XXI.A., 1 and 2. *Hymenophyllum armstrongii*, Kirk, nat. size; 8, fertile pinna, enlarged; 4 and 5, sori, greatly enlarged.

4. "On the relative Ages of the Australian, Tasmanian, and New Zealand Coal-fields," by James Hector, C.M.G., M.D., F.R.S.

The speaker's remarks were illustrated by diagrams and maps, and by a large collection of fossils which he had obtained during a recent tour in the Australian colonies.

ABSTRACT.

After describing the extent and position of the various coal-fields at present worked, he stated that from a comparison of the fossils he had arrived at the following results:—

Cretaceous epoch: Chief New Zealand coal; wanting in Tasmania and Australia, except, perhaps, in Queensland.

Jurassic epoch: Mataura series of New Zealand; Cape Paterson coal-fields of Victoria; Clarence River coal of New South Wales, and the coal-beds at Hobarton.

Liassic epoch: Clent Hill beds of New Zealand; wanting in Tasmania and Australia, except Queensland.

Triassic epoch: Wairoa beds of New Zealand; upper coal formation of New South Wales; wanting in Tasmania.

Permio-carboniferous: Kaihiku series of New Zealand; lower coal formation of New South Wales; Mersey coal-fields of Tasmania.

This view of the relative ages of those formations had just received remarkable confirmation by a late discovery; Mr. McKay, of the Geological Survey Department, who has recently been at work in the Canterbury Alps, having found plant-beds beneath the *Spirifer* beds of Mount Potts that are full of the leaves of the *Glossopteris*—a fern very characteristic of the upper and middle coal formations of New South Wales, and with them beds of graphite of considerable commercial value, which represents in an altered form the Newcastle coal-seams. Along with these occur remains of Saurian reptiles of immense size, of which large collections have been made. In conclusion, it was stated that only a very small portion of the area, coloured on the map of New South Wales as coal formation, contains valuable coal-seams, and that they were not without drawbacks. At Newcastle, where the principal collieries are situated, the seams have to be worked to an increasing depth by shafts, and require pumping. In the southern coal-field, the coal is worked by adits into the face of the mountain, and lowered by steep inclines in the same manner as our own Buller coal will be worked; but it has to be shipped from an exposed coast. The western district coal has all to be carried over the Blue Mountains by a railway that ascends and descends by zigzags, that answer well enough for passengers and light traffic, but must be rather costly for transporting coal. Dr. Hector stated that all he had seen increased his confidence in the value of our West Coast coal-fields, both as regards the quality and extent of the coal and the facilities for working them.

5. Dr. Hector described various recent additions to the Museum, which were exhibited: (1.) Ventral spines of a species of Banks' oar-fish, *Regalecus gladius*, recently cast up on the Farewell Spit, and presented by Mr. H. L. Wilson. Unfortunately, the whole of this rare species had not been procured, but a full-sized drawing was shown. It is like the frost-fish, but thirteen feet long, and one foot deep, with a high crest over the head, and the ventral fins reduced to two long rays or spines, which are elongated above the body, and furnished with an oval expansion of membrane at the tip. The colours of the fish are very bright and metallic. (2.) A specimen of the sea-trout (*Salmo trutta*), caught with rod and artificial fly in the Tasmanian fish-ponds, was shown, and compared with specimens at all stages of growth of the same fish reared in New Zealand. The distinct manner in which the specific characters were preserved in them, and also in a number of brown trout also exhibited, is opposed to the theory advanced by some that the Tasmanian fish are being hybridized.

Some other interesting fish were also exhibited, forming a small part of a large collection presented by Mr. William Macleay, F.L.S., of Sydney.

An interesting series of gem sands from Mudgee and the diamond drift of Bingera presented by Professor Liversidge, and also specimens illustrating his discovery of the formation of moss gold by the action of gentle heat on arsenical iron pyrites, together with specimens of the recently found native bismuth and tin ore of Tasmania, were also exhibited.

Eighth Meeting. 12*th January*, 1878.

W. T. L. Travers, M.H.R., F.L.S., President, in the chair.

1. "Further Notes on the Ornithology of New Zealand," by Walter L. Buller, C.M.G., Sc.D., F.L.S. (*Transactions*, p. 201.)

2. "On the Species forming the Genus *Ocydromus*, a peculiar Group of brevi-pennate Rails," by Walter L. Buller, C.M.G., Sc.D., F.L.S. (*Transactions*, p. 213.)

3. "On the Egg of the Huia *(Heteralocha acutirostris)*," by Walter L. Buller, C.M.G., Sc.D., F.L.S. (*Transactions*, p. 212.)

4. "On the Addition of the Red-tailed Tropic Bird (*Phæton rubricauda*) to the Avifauna of New Zealand," by Walter L. Buller, C.M.G., Sc.D., F.L.S. (*Transactions*, p. 219.)

The President remarked that the hop plantations drew large numbers of the small parroquet to certain localities. The sparrow on the contrary was useful in destroying insects, as was also the introduced minah. He agreed with the author that the pukeko were disappearing in some places. He thought it doubtful if the kakapo were plentiful in the Kaimanawa Ranges, as, if it were so, we should have more specimens.

Dr. Hector thought the Maoris did not go far into the bush at Kaimanawa. In 1869 when he explored those mountains he frequently heard the cry of the kiwi and observed the tracks which are made by the kakapos at certain seasons when they assemble on the bare grounds above the limits of the forests.

Mr. Chapman thought that a search for food had a good deal to do with finding certain birds so plentiful in certain localities. He thought that the little *Zosterops* would be destroyed by the sparrow.

5. "On Mill's Fourth Fundamental Theorem respecting Capital," by John Carruthers, M. Inst. C.E. (*Transactions*, p. 24.)

Dr. Newman did not agree altogether with the author's views. Political economy did not apply in the same way in all countries. It was a mistake to think that capital was only useful when in use. He quite agreed with Mill's theory with the limitations he puts on it. The author did not, in his opinion, understand the value of passive capital.

Mr. Young wished the discussion postponed, as he thought many objections might be made to the author's views.

The author, in reply, said that political economy had nothing to do with countries. It was a mathematical question and was either true or false; the axioms must be proved. He did not consider that anything had been said to show that he was incorrect in his

The President considered that it would be better to postpone the discussion. From what he gathered the paper went to show that the accumulation of wealth, unless employed in doing good to all classes of the community, was misapplied.

6. "On *Hymenophyllum villosum*, Colenso," by T. Kirk, F.L.S. (*Transactions*, p. 395.)

7. "Notice of the Occurrence of a Variety of *Zostera nana*, Roth, in New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 392.)

8. "On the Naturalized Plants of Port Nicholson and the Adjacent District," by T. Kirk, F.L.S. (*Transactions*, p. 362.)

Dr. Hector remarked that in Sydney and Victoria the variegated thistle is cultivated for feeding stock, where grass is scarce.

The following papers were taken as read:—

9. "On the Belemnites found in New Zealand," by James Hector, C.M.G., M.D., F.R.S. (*Transactions*, p. 484.)

10. "On the Mercurial Springs of the Bay of Islands," by Dr. Hector, Director of the Geological Survey.

ABSTRACT.

The author gives the result of a re-examination of the district in 1874, and contends that the brown decomposing sandstone, with lignite and carbonized vegetation mentioned by Capt. Hutton as containing the deposits of mercury,* is only a local tufaceous deposit formed by the springs, which mechanically precipitate incoherent grains of silica coloured with iron. An analysis of water from the springs made in 1869† shows that they are strongly acid and free from the soluble silica that forms the cement of the deposits at Rotomahana.

The springs escape round the terminal end of a floe of grey scoriaceous lava that has been ejected from a cone on the south shore of the Omapori Lake. This lava is quite superficial, and rests on the denuded surface of indurated marlstones belonging probably to the cretaceous series. Several streams take their rise from springs in the locality, and there is a chain of lakes which, from their position and relative level, are like the streams supplied by underground leakage from the lake, the level of the Omapori Lake being 748 feet, and that of the springs 630 feet above the sea.

The author considers that the thermal and mercurial qualities of the springs are not due to any active volcanic influence, but to chemical decomposition which is taking place in the under part of the lava floe, through which the waters are infiltrated.

11. On certain of the Mineral Waters of New Zealand," by William Skey, Analyst to the Geological Survey Department. (*Trans.*, p. 423.)

12. "On the Result of an Examination of certain of our Manganese Ores for Cobalt," by William Skey. (*Transactions*, p. 448.)

13. "On the Solubility of Calcic Carbonate in Solutions of the Alkaline Chlorides," by William Skey. (*Transactions*, p. 449.)

* Trans. N.Z. Inst., III., 252. † *Ante*, p. 425.

14. "On the Degree of Solubility of certain Earthy Carbonates in pure Water," by William Skey. (*Transactions*, p. 452.)

15. "On the Butterflies of New Zealand," by Arthur Gardiner Butler, F.L.S., etc. Communicated by John D. Enys, F.G.S. (*Trans.*, p. 263.)

16. "Notes on the Whales of the New Zealand Seas," by James Hector, C.M.G., M.D., F.R.S. (*Transactions*, p. 331.)

Annual General Meeting. *2nd February*, 1878.

W. T. L. Travers, M.I.R., F.L.S., President, in the chair.

Minutes of last annual general meeting read and confirmed.

ABSTRACT REPORT OF COUNCIL.

During the year nine general meetings were held in the lecture-hall at the Colonial Museum, which was kindly lent to the Society by the Governors of the New Zealand Institute.

Forty-eight papers were read on the following subjects:—Geology, 8; Zoology, 13; Botany, 15; Chemistry, 4; Miscellaneous, 8.

The total number of members is 221, of whom 29 were elected during the year.

The Council record with regret the death of the following members:—Alfred Ludlam, George Moore, and R. P. Orme, C.E.

The Society's Library has been added to during the year, and a catalogue is being prepared for printing. Several donations to the library are acknowledged with thanks from the Philadelphia Exhibition Commissioners, Dr. Hector, H. Siegel, of Vienna, and Professor Liversidge, Hon. Sec. of the Royal Society, N.S.W.

The Statement of Accounts shows that there is a balance to the credit of the Society of £99 2s. 2d., while a sum of £31 10s. (being one-sixth of the Society's income) has been handed to the New Zealand Institute in compliance with the rules.

Election of Officers for 1878.—*President*—Thomas Kirk, F.L.S.; *Vice-presidents* — J. Carruthers, M. Inst. C.E., A. K. Newman, M.B., M.R.C.P.; *Council*—James Hector, C.M.G., M.D., F.R.S., J. C. Crawford, F.G.S., W. T. L. Travers, F.L.S., Dr. Buller, C.M.G., F.L.S., C. Rous Marten, F.M.S., F. W. A. Skae, M.D., F.R.C.S.E., Martin Chapman; *Auditor*—Arthur Baker; *Secretary and Treasurer*—R. B. Gore.

The following papers were taken as read:—

1. "On Floods in Lake Districts and Flooded Rivers in general, with Methods adopted for their Prevention and Control," by H. P. Higginson, M. Inst. C.E. (*Transactions*, p. 180.)

2. "On Paper Currency, being a Reply to a Paper by John Carruthers, M. Inst. C.E,"* by J. Young.

* *Ante*, p. 24.

ABSTRACT.

Mr. Mill defines wealth to be "all useful and agreeable things which possess exchangeable value," and capital to be "a stock previously accumulated of the products of former labour." Mr. Carruthers proposes "to define wealth to be 'everything in the world which is useful or agreeable to man,' and capital the 'ownership of that wealth.'" The author sees no reason to depart from Mr. Mill's definitions, and does not think Mr. Carruthers' definition of capital any improvement upon that of Mr. Mill. There is a sense in which nature's bounties may be converted into capital. By nature's bounties, he means the rays of the sun, air, and water, and such-like things; for example, the owner of a piece of land by a running stream can at any time command a higher price for his land than the owner of another piece, equally good in all other respects, which is at a distance from water. Again, if the stream is of sufficient volume, especially if the fall be considerable, the fortunate owner becomes possessed of an inexhaustible fund of potential energy, which he may turn in various ways to his own use and benefit, and thereby convert it into capital. He can apply the energy of the stream to drive machinery, and by that means save the expense of a steam-engine and the fuel necessary to drive it. He can, if need be, irrigate his lands and increase the produce of his fields. Every farmer knows the value of a situation on the sunny side of a hill. The farmer thus situated is able to avail himself of the earliest rays of the sun, and of the concentration of those rays at a later period of the day to promote vegetation. He in fact converts the potential energy of the sun's heat into a means of growing crops, and thereby increasing his income. He will be able to produce crops earlier than, and superior in quality to his neighbour whose land lies on the other side of the mountain range, and who receives the sun's rays later in the day and at a more acute angle.

The author then gives his reasons for disagreeing from Mr. Carruthers on two or three points of importance. It is not a difficult matter to detect the fallacy that by creating a paper currency we should be giving that which costs almost nothing for the product of labour. This would be doing violence to a fundamental law. It is, in fact, saying that we can give a penny for that which costs a pound. The error lies in supposing that any power or authority, however great, can create a fictitious or artificial value. This is sufficiently disproved by the fact that, wherever the experiment has been tried, it has resulted in signal failure. The scheme of John Law, in France, in the reign of Louis XV., is a case in point. But Law's scheme had one redeeming feature as compared with the theory of Mr. Carruthers, inasmuch as his paper currency was supposed to represent the possessions of the great landed proprietors.

The author gives other instances of attempts to set up a paper currency, notably the case of the United States.

No legal enactment can override an universal law. The idea of a paper standard of currency is not a new one, as will be seen by what has been already advanced. There have been visionaries without number who have talked the wildest nonsense on this subject. Yet all enlightened nations have found it necessary to adopt metallic standards. And these metals are adopted simply because they are scarce and costly. They represent work and labour done, and they are a convenient medium of exchange because they are scarce, and require the expenditure of energy to the value that they represent to obtain them. Tens of thousands of men, with various mechanical appliances, are employed in obtaining the precious metals, and others are employed, skilled artizans, with costly machinery, to refine them and coin them into money. If one buys an article for a pound,

and gives the vendor a sovereign, he gets value for value; but if tendered a piece of paper, and told that it is worth a pound, he will probably dispute the dictum. The case is different with a bank note, because the public have confidence in the banker, that he is able to pay specie to the amount specified on the note, upon demand.

The author then gives his reasons for disagreeing from others of Mr. Carruthers' propositions. He says that Mr. Carruthers' argument appears to him to involve two propositions, namely, 1st, "That no *real* injury is done to the working classes by what he may call the disturbance of the equilibrium of labour. 2nd. That benevolence invariably defeats its end, and results in actual injury to the poor." With regard to the first: Political economists of this school pass too lightly over the important consequences which must ensue to a section of the labouring classes by the sudden cessation or diminution of any of our national industries. They console themselves with the fact that capital which is withdrawn from one branch of industry can be immediately employed in another. And hence they say no harm is done to the working classes as a whole, because if there is a falling off of work in one department of industry, there is a corresponding increase in another. Hence it follows that any disturbance of an industry consequent upon the withdrawal of capital, to be turned into another channel, results in a real injury to the labourers and artizans thus deprived of their legitimate employment. And any corresponding benefit conferred upon another section of labourers, will not counterbalance the evil.

With regard to the second proposition: The author takes it for granted that it is the duty of the State, or of the wealthy classes, to support those who are in want. He does not understand Mr. Carruthers to mean that he is opposed to charity in general, but to that particular part of it dispensed by private individuals. Were it so, he should confront him with a very different line of argument. Objection is taken by Mr. Carruthers to the rich man dispensing charity, because he gives away money that would otherwise be used in the purchase of manufactured articles, and thereby robs the poorer classes of a portion of their income. By a parity of reasoning, it can be shown that, if there were no poor-rates, the rich man would have still more to spend. And if there were no taxes at all he would have a still larger sum at his command. Thus we come to the conclusion, that the poorer classes pay for the rich man's charity; they pay his poor-rates, and indeed all the taxes of the nation, and the rich man pays none at all: for it follows, as a natural consequence, that the charities, rates, and taxes paid by the rich would, if they were not paid, go into the pockets of the poor—in fact, to a *reductio ad absurdum.*

It is not stating the case fairly to say that "The corn sent to feed the starving millions of India was taken from the labouring man's stock." It was simply an ordinary commercial transaction, so far as the mere export of corn was concerned. Corn is grown for sale, just the same as manufactured articles are produced for sale. If there is a superabundance of corn in one part of the world and a scarcity in another, the current of trade immediately sets in to restore the equilibrium. And the case of India is no exception to the rule. We might as well say that the corn annually exported from the Australian colonies and New Zealand to Europe, is taken from the poor man's stock.

3. "Notice of the Discovery of *Monoclea forsteri*, Hook., in New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 418.)

4. "Descriptions of new Plants," by T. Kirk, F.L.S. (*Trans.*, p. 419.)

5. "A revised Arrangement of the New Zealand Species of *Dacrydium*, with Descriptions of new Species," by T. Kirk, F.L.S. (*Trans.*, p. 883.)

6. "An Enumeration of recent Additions to the New Zealand Flora, with critical and geographical Notes," by T. Kirk, F.L.S. (*See Appendix.*)

The retiring President then delivered the following Anniversary

ADDRESS.

It is my duty, on retiring from the office of President of this Society for the past year, shortly to refer to its labours since the last annual address was delivered, and I can only regret that urgent business engagements and the limited time at my disposal prior to my contemplated departure for Europe have prevented my doing such justice to the subjects of those labours as they deserve. Unfortunately, too, my predecessor was unable to deliver the usual address, and the Society was thus deprived of the advantage of his review of the work done during his term of office, besides which he has necessarily left the duty of doing so to less able hands.

A glance at the Transactions of the New Zealand Institute for the year ending May, 1877, will, I am happy to say, show that the interest taken in those classes of scientific subjects which have ordinarily occupied the attention of members of this society, has in no degree abated, for we find that of the miscellaneous essays 19 out of 29 were contributed by members of this Society, of those on zoology 12 out of 38, on botany 12 out of 15, on chemistry the whole, and on geology 5 out of 9, whilst several of the remaining published papers are reprints from the contributions of foreign authors to the "Annals and Magazine of Natural History," a fact which increases the proportion in which our society contributed, during the year in question, to the Transactions of the Institute.

But it is not alone by the number of its contributed papers that our Society may be considered as distinguished in its labours during the year now under review. Many of these papers are of high scientific value and interest, not merely because the facts stated in them have resulted from careful observation—a matter of primary importance in all scientific work,—but because the conclusions deduced from those facts are thought out and given in the spirit of sound philosophical enquiry.

Amongst the more important contributions I may instance those of Dr. Newman, Mr. Rous Marten, Mr. Coleman Phillips, Dr. Hector, Dr. Buller, Mr. Kirk, Dr. Curl, Mr. Thomson (the Surveyor-General), Mr. Buchanan, Mr. Skey, and Mr. A. McKay; and although some of these papers open questions of a controversial character, there can be little doubt of their respective values as additions to the common stock of scientific knowledge.

As in the preceding year, so in the past one, our Society takes foremost rank in contributions to the Transactions, for I find that it has contributed 8 miscellaneous essays, 13 papers on zoology, 12 on botany, 8 on chemistry, and 8 on geology, whilst the range of subjects is in no degree narrowed, and the treatment has been characterized by the same amount of care and research.

It is, however, fair to observe in this connection that our Society has the advantage of numbering amongst its members several gentlemen connected with the scientific staff of the Government, who naturally enjoy far greater opportunities of observation than fall to the lot of the majority of the members either of this or of the other societies affiliated to the Institute. It cannot be denied, however, that in some parts of the colony such opportunities as do occur are not taken advantage of, and thus many facts, which, if

recorded, would be valuable, by remaining unrecorded are lost to science. This is a matter much to be regretted, more especially when we consider the remarkable position which New Zealand occupies as a field for scientific enquiry.

As you are doubtless aware, the soundings taken by the "Challenger" between Australia and New Zealand during the late scientific voyage of that vessel, have shown us that there is indeed between these two countries a very great gulf; for although it appears that for some 250 miles to the westward of New Zealand the depth of the sea increases slowly and is comparatively small, it also appears that, beyond that distance, the depth increases with great rapidity, ultimately reaching 2,600 fathoms, or sufficient to submerge the highest points of the Southern Alps. It is in no degree surprising, therefore, that little analogy has been found to exist between the natural productions of these two countries, for it has been found, for example, in the case of the Indo- and Austro-Malayan divisions of the Malay Archipelago, that a comparatively small expanse of deep water has been sufficient to account for immense diversities in natural productions, even between places which correspond in their main physical and climatal conditions. It is, moreover, well ascertained that the present distribution of life over the surface of the globe is the result of the latest changes which have taken place upon that surface, and it is therefore abundantly clear that, if New Zealand had ever been connected by land with the Australian continent, it must have retained some of the peculiar types of life which characterize that country. Singularly enough, the analogies of our fauna and flora are far more with those of South America and the southern parts of Africa than with those of Australia, indicating, indeed, a former land connection between these several places, notwithstanding the enormous expanse of sea by which they are now separated.

I may here mention one very curious instance of this analogy. Amongst the more remarkable insects of New Zealand is the *Peripatus*, a creature only found in decaying wood, upon which it probably feeds, and which resembles an ordinary caterpillar in its appearance. But this insect never passes to the pupa or imago stages, being oviparous in the larval condition, and is absolutely incapable of passing alive over even the smallest space of salt-water. Now the same insect is found in Chili and at the Cape of Good Hope, and in both cases under precisely the same conditions as in New Zealand. But no such insect is found in any part of Australia or Tasmania. It will be remembered, moreover, that the vegetation of the south-western coasts of South America resembles, in a remarkable degree, that of the western coasts of the South Island, so much so, indeed, that Mr. Darwin's vivid and interesting description of the former might almost be applied *verbatim* to the latter district. The same differences exist between the natural productions of Australia on the one hand, and of the islands immediately to the northward of New Zealand (such as Norfolk Island and New Caledonia) on the other, whilst considerable analogy exists between those of our islands and of the islands to the northward.

But a careful consideration of our own fauna and flora leads to the further conclusion that New Zealand has occupied an isolated position, as a zoological and botanical province, for a vast period of time, and the circumstance that, until quite recently, it was unvisited by civilized man, and was therefore saved from a class of interferences calculated to exercise a profound modifying influence upon its natural productions, invests those productions with the very greatest interest in a scientific point of view. It becomes our duty, under such circumstances, to exercise the utmost diligence in observation and in the collection of facts to be afterwards used in our attempts to solve the problems which the character of our fauna and flora offer for solution.

As a patent instance of the necessity for, and advantage of, careful observation, I may call your attention to the controversy which, for some years past, was carried on between writers in this colony as to the moa. Dr. von Haast, in a considerable number of papers, and up to the very last, has contended that these birds were exterminated long before the occupation of New Zealand by the present native race, assigning their destruction, indeed, to what he terms—in contradistinction, I presume, even to their immediate predecessors in occupation—"a race of autochthones." Dr. von Haast has been supported in his contention by other writers of minor note, who, however, appear to have had very little opportunities of obtaining correct information, but who—like the proverbial far-off cow, which is always supposed to have long horns—might, in the mind of persons at a distance, have been supposed to possess special means of knowledge.

On the other hand, Dr. Hector and other writers whose opportunities of observation and of obtaining correct information were very large, always contended that the extinction of these great birds was a comparatively recent matter. It is fortunate that evidence of a very conclusive character has been obtained, which has enabled the highest authorities of the day to pronounce judgment upon the matter, which has been done emphatically against Dr. von Haast's contention. This judgment is to be found in Professor Owen's last paper on the *Dinornidæ*, in which he uses the following language: "As to the geological relations of the bones of the moas, reviewing the whole evidence, I concur with the learned Professor Igino Cocchi in referring *Dinornis crassus*, *D. elephantopus*, *D. giganteus* (var. *robustus*), and *D. ingens* to the 'Periodo attuale,' which is equivalent to the 'neolithic' or 'recent period' of 'Ethno archæology.' At the same time I think that certain remains from the fluviatile deposits in the North Island, representing the species *Dinornis giganteus*, *D. ingens*, *D. struthioides*, and *D. didiformis*, of a heavier and less recent character than the bones from the South Island, have come from birds which lived in 'post-pliocene,' or quaternary, or even earlier times. But all the species seem to have existed and abounded when the present race of Maoris set foot on New Zealand, and the final extirpation to have been of comparatively recent date."*

Upon another subject of equal, if not indeed of greater interest, a controversy is still being carried on, but with comparatively little satisfactory material for the determination of the points at issue—I allude to the question of the origin of the present New Zealanders and the date of their first arrival in these islands. I ventured to take part in this discussion by reviewing the traditions collected and published by Sir George Grey, in which a period of 600 years back is fixed as that of the arrival in these islands of the first Maori immigrants. The object of my paper was to show that, although the traditions in question afford that class of testimony which traditions usually offer in support of the assumption that the present race is descended from the union of immigrants from the northward with people previously in occupation, they give (taken by themselves) no assistance whatsoever in determining the date at which or the locality from which this immigration took place. Upon this subject, also, we have Dr. von Haast and others on the one side contending that the present race is of very recent introduction to these islands, whilst persons well acquainted with Maori lore, supported by considerations which are not touched by the learned doctor and his friends, are clearly of opinion that the story of the Maori migration to these islands is a very old one indeed. My own opinion is that we are as yet utterly wanting in the materials necessary for the determination of the question at issue, and that we ought to suspend all judgment upon it until the traditions and history of the allied races in the other Pacific islands, with full

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* Trans. Zool. Soc., X., pt. iii., p. 185.

notices of their habits and customs, have been collected and become available for purposes of comparison. But it is obvious that the necessary materials for settling this question will be incomplete, if we, on our side, neglect the opportunity, now rapidly passing away, of putting upon record all that can be learnt upon the points at issue, from the Maoris themselves, whose *tohungas*, or chief priests, are in possession of much lore bearing upon them.

In Dr. von Haast's recent address as President of the Philosophical Institute of Canterbury (which will appear in the forthcoming volume of the Transactions),* that learned gentleman discusses the antiquity of certain raddle and charcoal marks upon some limestone rocks in the Weka Pass, on the line of road between Canterbury and Nelson, which (on the authority of one Matiaha Tira Morehu, a Maori residing at Moeraki) he attributes to a race of people called Ngapuhi (whom he characterizes as "somewhat mythical"), to whom Matiaha also attributes "the extinction of the moa and the heaps of pipi shells found in the mountain ranges," on the ground, as to the latter fact, that the supposed people were great travellers. But Dr. von Haast thinks he has found out what would certainly be a point of great importance if correct in regard to these so-called paintings, namely, that the "mythical Ngapuhi" were in the habit of using "some oriental language" (previously identified by him as the "Tamil," from comparison of what he terms fragments of letters with the inscription on Mr. Colenso's bell†) for the purpose of describing the wretchedly rude figures drawn on the rocks. Except a very fair sketch of a hat (something like a bishop's hat) which, if it be intended for a hat, speaks for itself, the figures certainly require explanation, but the learned doctor's theory as to the origin of these scratchings would, if accepted, lead us to the remarkable conclusion that "a people sufficiently civilized to teach their children reading and writing in some oriental language," and who used it to indicate the meaning of the very rudest drawings upon a rock shelter, should have left no other trace of their civilization, and should have been content to carry cockles for food, from the sea-shore to the distant Southern Alps. I notice this remarkable portion of Dr. von Haast's address in order to show how utterly indefensible it is to indulge in such speculations on the bare authority of an illiterate Maori, descended no doubt from some Ngatikahungunu migrant, whose knowledge of the South Island and its former inhabitants only dates from the well-known migration of a part of that tribe, some 200 years ago.

It will be seen from the foregoing remarks, that problems of very great interest are presented to us for solution, and that the difficulty of solving them is in no degree lessened by such ill-advised speculations as those to which I have referred. But let me enquire further what we have to do. We have, in the first place, to perfect the classification of our own fauna and flora—a work in which we are happily assisted by some of the greatest living writers on natural history. We have then to determine the relations of our fauna and flora to those of other countries—a work for which perfect materials will not be attainable for many years. We have, moreover, to carry back our enquiries on these points into past geological periods, in order to ascertain what relations the existing natural productions of these islands bear to those of which the remains have been preserved to us in the great "Stone Book" of Nature; and for all these purposes it is essential that we should be unceasing in observation and careful in its record.

In order to illustrate the nature of the labours cast upon us, let me again refer to the history of the great struthious birds which formerly roamed over the plains and open places of these islands. The fact of their former existence has, as we know, been long

* *Ante*, Art. IV. † Trans. N.Z. Inst., IV., pl. 2*a*.

established beyond doubt. Their extinction is also beyond doubt; and it has now become abundantly clear that that extinction took place in comparatively recent times. But although we have reason to believe that the Maoris are possessed of full accounts of the habits of these birds, and of their own modes of hunting and otherwise capturing them, we have, as yet, collected only the most fragmentary portions of those accounts, and but little even of what we have collected has been published. And we know absolutely nothing of the origin, in past time, of these remarkable animals, no remains of any birds which can be identified as belonging to the *Struthionidæ*, having yet been discovered even in later tertiary formations, although those of the penguin have been found in the upper chalk or older eocene rocks.

There is one especial point, too, in connection with these huge birds which merits particular attention. The existing species of the *Struthionidæ* are peculiar to the southern hemisphere, and, looking to New Zealand as an instance, it would not have been surprising had we found many species in each of the several localities which this family now inhabits. And yet South America is the only one of those habitats which affords more than one species—namely, the *Rhea americana* and the *R. darwinii*, which never associate together, and each of which is confined to a particular range of country. Africa possesses only one species, the *Struthio camelus*; Australia also one, the emeu or *Dromaius novæ-hollandiæ*; whilst the cassowary is confined to Java, Sumatra, Banda, and the Moluccas. Another large struthious bird, the mooruk, the nearest living form of the extinct moas, has been found in the Solomon group; and, as you are no doubt aware, the remains of a huge struthious bird, the *Æpyornis*, have been discovered in Madagascar, but as yet, at all events, only the remains of one species have been obtained.

We have therefore this very remarkable fact presented for our observation in regard to the extinct *Struthionidæ* of New Zealand—that, within a comparatively small range, a large number of different forms presenting apparent specific distinctions co-existed, and must, looking to the circumstances in which their remains were obtained, have associated together freely. I may here remark that Professor Owen does not subscribe to the further generic subdivision of *Dinornis*, as proposed by Dr. von Haast. He says:—"Dr. von Haast has followed his ornithological countryman's procedure in a further generic subdivision of the *Dinornithidæ*. *Dinornis didiformis*—the type of Reichenbach's genus *Anomalopteryx* (1850)—is the type of Von Haast's genus *Meiornis* (1874). The *Eurapteryx* of Von Haast (1874) is the *Syornis* of Reichenbach (1850), both represented by *Dinornis casuarinus*. * * * Those genericifications of the accomplished author of the 'Handbuch der speciellen Ornithologie.' have not met with acceptance or favour at the hands of subsequent systematists. Whether the parallel labours of Dr. von Haast will be more fortunate remains to be seen."* It must, however, be noted as regards New Zealand that, except man, these huge birds had no enemy, and must have remained completely undisturbed for a period quite sufficiently long to account for the formation of the many apparent species whose remains have been discovered.

Another point of great interest presented to us, and already alluded to in this address, is "The whence of the Maori?" Upon this subject, as I have before observed, many papers have appeared in the Transactions of the Institute, but the various writers have as yet failed to solve the problem. Mr. Wallace, in his most valuable and interesting account of the natural history of the Malay Archipelago, has pointed out, as the result of careful study and observation, that all the varieties of people which

* Trans. Zool. Soc., X., pt. iii., p. 174.

inhabit that archipelago and Polynesia may be referred to an admixture of Mongolian and Papuan elements. It was, as he mentions in an appendix to his work, at one time thought the study of crania offered the only sure basis for the classification of man, but he refers on this point to the fact, that an opinion is now beginning to gain ground, that, for this special purpose, the study of crania is of very little value—an opinion boldly avowed by Professor Huxley, one of our greatest living ethnologists. He further urges, that we are most likely to arrive at correct views as to the origin of any particular section of the peoples in question by a careful study of their habits and customs; and he has arrived at the following conclusions:—Firstly, that the numerous intermediate forms of man which occur among the countless islands of the Pacific were originally the produce of a mixture of some lighter-coloured Mongol race with the dark Papuans; secondly, that these intermediate races are not merely the result of this mixture, but are, to some extent, truly intermediate or transitional; and lastly, that, although it is undoubtedly true that there are proofs of extensive migrations amongst the Pacific islands, which have led to a community of language from the Sandwich group to New Zealand, there is no evidence whatever of recent migration from any surrounding country to Polynesia, since there is no people to be found elsewhere sufficiently resembling the Polynesian race in their chief physical and mental characteristics.

I might indicate many other and, indeed, far more important subjects which require the attention of our scientific bodies, but I should weary you. It is sufficient to point out that the development of the material resources of a country is intimately connected with the progress of scientific enquiry amongst its people, and, therefore, how essential it is that a taste for such enquiry should be cultivated amongst us. In conclusion I may venture to express a hope that no relaxation will take place in the efforts of those who are engaged in scientific research in this colony, and that their labours will be such, in the future, as to deserve the hearty commendations which those in the past have received from the highest authorities in Europe.

At the conclusion of the President's address, on the motion of Dr. Newman, a vote of thanks was unanimously accorded to Mr. Travers for his address and for the able manner in which he had presided over the Society during the past year.

On the motion of Dr. Buller a vote of thanks was also given to Mr. A. Baker, who had kindly undertaken the office of auditor to the Society for several years past.

A *conversazione* was then held in the Colonial Museum by permission of the Board of Governors of the New Zealand Institute, at which about 400 members and their friends, including His Excellency the Marquis of Normanby, G.C.M.G., were present.

AUCKLAND INSTITUTE.

FIRST MEETING. *28th May*, 1877.

R. C. Barstow, President, in the chair.

New Members.—R. Cameron, P. Dignan, M.H.R., J. H. Greenway, S. E. Hughes, J. Symons, J. L. Tole, E. K. Tyler.

The President then delivered the following anniversary

ADDRESS.

In the first place I must thank you for the honour which you have conferred upon me in electing me as your President for the current year. I am afraid that a Society instituted for the advancement of Art, Science, and Literature, has not shown itself artful by such choice. Regretting, both for your sakes and my own, that I possess no scientific attainments, have no literary tastes, and am devoted to no art, I can only promise that by industry and attention to the objects of the Museum and Institute I will endeavour to remedy these serious deficiencies. The means laid down by the rules of our Society for the attainment of its ends, are a Museum, a Library, Lectures, and Meetings of Members. I look upon the first in order of these as the most important, because the most direct; the impression on the brain is more positive, more accurate, more indelible when conveyed by ocular inspection of a substance itself than by perusal of a written description of it, or than by listening to a lecture upon it; besides the visual conception is the speediest mode of acquiring comprehension,—take, as an example, a specimen of a stuffed bird, you look at it, and in an instant you acquire a knowledge of the size, colours, and partly of the habits of the living bird,—turn to a book on ornithology, you find the height, a description of the colours, wings, tails, claws, and other particulars, which you must put together for yourself, and then trust your imagination for the appearance of the bird, unless there is a plate to help you; and even should there be one, only compare the picture with the reality, and you will be struck with the advantage possessed by the actuality over the best possible resemblance. So, too, more especially of minerals, a look, a handling, and how much more you feel to know about them, than by a geological exegesis; not that I am despising this latter, but only extolling the former modes. Look at machinery; how long would it take most of us to comprehend the working, say, of a locomotive engine by studying a mere written account, or listening to a descriptive discourse, even from the most accomplished of engineers! True, accompanying drawings may assist you, and render that intelligible which otherwise would be altogether beyond your powers, but how much more facile it appears when, examining for yourself the complicated apparatus, you trace the supply of water and coal, the generation of steam, the manner in which its power is controlled and directed, the multitude of appliances by which the engineer regulates the speed and motion of his mighty monster, and renders it subservient to his will, and although pure science must be allotted to library or lectures, in most of its branches illustrations by experimental apparatus are necessary to exemplify the various processes involved.

I need not recapitulate the several objects which our Museum contains, for most of you are familiar with these, but I wish to say a few words upon our deficiences.

We require to make as perfect an assortment as can be got together of all descriptions of implements, weapons, and manufactures of the Maori race and their South Sea congeners—a task becoming more difficult every day. Students in ethnology will require these things to guide them. As an instance of such use, I may mention that, looking the other day at engravings of the sculpture on a temple at Palengue, in Central America, I was forcibly struck by their wonderful resemblance in feature and attitude to the well-known Maori "heitiki."

We need a specimen of every kind of local animal, seeing, as we do, that many of the indigenous species are rapidly becoming extinct, as the native dog and rat, both at one time largely used for food; birds, too, are disappearing; quail, once plentiful, are no more so; tuis and bell-birds rarely seen. All the natural productions of these islands should be represented, both for our own instruction and for that of strangers, who, visiting us, desire to carry away with them a knowledge of our resources. But, in addition to objects of these classes, obtainable on the spot, there are other materials to be sought elsewhere, which are as essential to us all.

Many of us who can look back for fifty years must be filled with wonder at the gigantic progress which has been made within that time in nearly every science which conduces to the comfort and convenience of man;—the invention of locomotives, ocean steam navigation, electric telegraphy, photography, medical anæsthetics, are but a few instances. Many of these, though originated whilst we were in the mother country, have been vastly improved and developed during our sojourn here; and it is necessary, for the education both of ourselves and children, unless we desire to drop behind in the march of human advancement, that we should possess models and scientific apparatus. Without converting our building into a polytechnic, or attempting ourselves to become savans, we must devote some little attention to these matters if we wish even to attain sufficient knowledge to enjoy the perusal of a daily newspaper.

In other ways the world gets wiser. Are we to keep pace?

Let us turn to history. Most of us who have passed middle age must look back with regret upon the many hours wasted in our youth in learning what was in those days termed "ancient history," but which patient research and scientific investigation has of late largely relegated to the domain of myth or fiction. How did *we* study this history? Did we start from any fixed or known point, and then trace downwards, by successive steps, ascertained facts, and their deducible effects, age after age? No. We began, so to speak, in the clouds: in Greek history—the migration of the Pelasgi or Deucalion's flood; in Roman—Romulus and Remus, with their wolf-mother, were taught us as dogmas which it was heresy to disbelieve: and on these foundations were built up, by layers of consecutive fables, stories which passed for accounts of events.

The study of comparatively modern, or even contemporaneous history, is beset with many difficulties, not the least being the danger of being misled by the colouring with which political partizanship has tinged the authors' narratives; but beyond this a sort of semi-excusable nationalism prevails, which makes an Englishman prone to unduly expatiate on those portions of his country's career which have been in his eyes more especially glorious, passing by or palliating topics of a humiliating kind,—sends a Scotchman to Wallace and Bannockburn, an imaginative Irishman to the Tuatha Danaans, Firbolgs, and Halls of Tara. Only read the English, French, and Prussian accounts of the battle of Waterloo: but for the recurrence of the same names of persons and places, one could hardly believe that the three relations pertained to the one event!

So also of ancient history, when, if not written for the purpose of advocating one or another scheme of political government—democratic, oligarchic, or monarchic—it is biassed by the patriotic feelings of the writer. Many, too, of the passages of these authors have been palpably corrupted either by carelessness of transcribers or by wilful alterations. Years of patient labour have been bestowed by learned men in endeavouring to elucidate the readings of perplexing or contradictory paragraphs, with by no means satisfactory results.

But sixty years have passed since the younger Niebuhr, not content with having read nearly every written history, resolved to verify, as far as possible, the accounts of the historiographers by a minute and critical examination of the ruins of buildings mentioned, a survey of sites described in their works. He more especially devoted himself to Roman sources, and speedily came to the conclusion that much, if not all, the so-called Roman history, prior to the first Punic War, was by no means trustworthy. Many scholars, more or less convinced by Niebuhr's facts and arguments, treated Greek history in a similar manner, the result being a rude shock to what had become an established faith. After doubt came attempts at reconstruction; a more thorough research of all the most world-renowned localities was organized; Dr. Young's and Champallion's attempts to decipher Egyptian hieroglyphics, and partial success, led to many collaborateurs following in their tracks; Egyptian annals going back for thirty centuries before the Christian era have been compiled, and though much may be doubted, these facts remain—conferring more authenticity than the often retranscribed manuscripts of early classic writers—that in many instances the inscriptions on stone or writings on papyrus are of the same antiquity as the events related, and have come down to us unaltered by succeeding generations. But stone even has not always proved a permanent medium for conveying records to posterity; in the Assyrian excavations of Rawlinson, Layard, Smith, and others the earlier inscriptions or carvings on alabaster or stone have often been partially effaced. In some cases the stone dado round rooms has been reversed, and the same material re-used to pourtray the triumphs or solemnities of a later dynasty. These ancients, however, had discovered a material as durable even as stone, and easily worked, for recording events or myths. Slabs of clay had characters incised upon them, were then baked, and thus defied that great destroyer—fire. Thousands of broken tiles of this kind, ruled into columns, and numbered on the back or bottom, have been exhumed at Nineveh; the fractures having been caused, partly by the fall of the building containing this library, partly by disintegration through moisture. The date of the manufacture of these tablets has been fixed as commencing with the reign of Assur, about 1500 years B.C., and concluding with the reign of Assurbanipal, about 670 years B.C., say 230 years later than the Arundelian marbles assign as the age of Homer and Hesiod. Many of these later Assyrian tiles are not the originals, but copies of Chaldean or Babylonian tiles of far greater antiquity, mentioning only kings reigning at this latter city at least 900 years antecedently. It appears that the Assyrian monarchs besides committing to these clay tablets the annals of their own respective reigns, caused copies to be made of the tablets of other states for the royal library. This has been confirmed by the discovery on still more ancient sites of pieces of tablets of earlier work narrating the same story. Incredible labour has been bestowed upon putting together corresponding fragments of these many thousand broken tablets (I believe no perfect one has been found yet), some have been partially completed, the cuneiform inscriptions interpreted, and amongst valuable discoveries, most wonderful corroborations of the Mosaic description of the deluge and rescue in the ark distinctly made out.

Mr. Smith, our highest authority, believes that a very early period may be allowed to some of the Babylonian tablets, but names Urukh, who reigned at Ur, about 2,000 B.C., as the earliest king to whom any of the existing tablets can be attributed with any degree of confidence. We know that Abraham, according to the book of Genesis, came originally from this same Ur, and that his vocation, according to Usher's chronology, was 1,921 B.C., or, according to Josephus, 2,083. Is it possible that an account of the deluge was brought from Chaldea by Abraham, handed down through his descendants to Moses, and that the condensed narrative of Holy Writ can now be retraced to its original and ampler source? Quite recently Dr. Schliemann, after years of excavations on the spot which he considered as the site of Ancient Troy, passing through, first, the ruin of a modern town,—next of an earlier one of about the age of Alexander the Great,—thereafter finding a third layer of wrecked abodes, with only rude stone implements, arrived at last, at a depth of from 38 to 50 feet from the surface, at the original débris of the earliest habitations; here, in what he calls the remains of Troy itself, metal is again found; gold and bronze, with pottery, demonstrating that the more civilized Trojans made way for a ruder people, who were again succeeded by Greeks. Animated by these discoveries, Schliemann arranged for further searching for Homer's heroes, and has, at Mycenæ, just as described by the old blind poet, found tombs containing many golden objects, but nothing indicating the use of iron by the long-buried race. Iron, indeed, is mentioned in the Iliad, but only as used for arrow-heads; thus, whilst much which was accounted "history" can be proved to be fiction, there seems every probability that, in song, we shall find many facts, embodied, indeed, in mere poetic colouring matter, which will tend to give us stepping-stones across the flood of unknown time.

The spirit of enquiry has not been limited to those countries which—like Egypt, Chaldea, Greece, Rome—have left behind them records for our instruction as to their places in cosmography; as, in New Zealand, we have hunted up the kitchen middens of the moa-hunters for the weapons and utensils of the early inhabitants of this land, so elsewhere a similar process has been applied to caves, tumuli, gravel beds, lake dwellings, and all sources whence light could be obtained as to the ways and means of prehistoric or early man; the importance of the discoveries thus made caused Ranke, the first of living German historians, when bringing out three years ago a second edition of his Prussian history originally published in 1848, to re-write all the earlier portion of it, assigning as the reason in his preface, "not only has the knowledge of events, been largely increased by zealous and successful enquiry, but the general range of view has been widened."

One of the first questions which we naturally ask ourselves when considering the early history of the human race, or anthropology, as it has been termed, is—When, geologically speaking, did man appear on the earth? with what animals was he contemporaneous? We all know that a world—in some essentials this world, though under very different conditions from the present—had an existence countless ages ago, and that many remains of gigantic and wonderful animals have been disinterred under a variety of circumstances; but you must by no means suppose that all these varieties of life were coexistent: thousands of years must have separated them. The great saurians had departed ere many animals now extinct had even appeared. We know that animals do disappear from certain countries, and even from the face of the earth. The wolf, the beaver, the reindeer inhabited the British Isles within dates which are fixable; but, though man's bones are found in England with those of the hyena and cave-bear, we lose ourselves when trying to assign the period of their intermixture.

Geologists have formed an opinion that the two latest grand changes in the world's condition have been caused by the action of ice, and have named these as the "glacial" ages, separated by an "inter-glacial" period of undefinable length: the alpine glaciers are remains of the later ice age; it must have been in some such time that the south of France could have been inhabited by the multitudes of reindeer and mammoths, of which remains have been found: we know that these were dwellers in extremely cold countries, and that the latter has been long extinct, the most recent vestiges of it having been discovered enveloped in snow. But coeval with these animals in the south of France there was man: for some time their bones, which had been split longitudinally, were the chief evidence that man had operated upon these, one of the distinguishing characteristics of man being, that whereas many animals use material, man alone uses implements; and these broken bones were in juxta-position with the stone tools used for their fracture; but now this surmise has received confirmation by the discovery of an etching of the representation of reindeer fighting, drawn upon a piece of that animal's horn, and of an excellent resemblance of a mammoth, at Dordogne, scratched upon a piece of mammoth ivory: these were human handiwork, and made by men who must have seen what they drew; for how else could they have derived their knowledge of the appearance of these animals?

I am inclined to look upon these two specimens of human workmanship as the earliest assignable traces of the existence of man; some stone implements may be earlier, but cannot be shown so to be—first, from their dating back to the glacial period; secondly, because in the earliest works of the nations whose remains have come down to us, man is often pictured in conjunction with animals, but whether with lions, dogs, horses, bulls, or any other, invariably with animals still existent, and whose existence was compatible with the present climatic conditions.

On the banks of the Arno, near Florence, are vast accumulations of fossil bones, not, indeed, of mammoth and reindeer, but of elephants, rhinoceros, hippopotamus, and bear; were these animals driven before the advancing waters of the deluge to some supposed refuge, and there overwhelmed? Was the deluge the cause of the second glacial period? If the fountains of the great deep were broken up, why should not circumpolar ice have been thereby drifted over submerged Europe till arrested by the Alps? the vast mass would be ages in thawing, and the cold thus developed would permit the mammoth, reindeer and man to associate; ice-carried boulders dropped in many parts of Europe show the course taken by the invading arctic mass..

In assuming that the second glacial period was thus caused by the flood, the latest possible date has been attributed to it; on any other suggestion it would have been anterior, and then these two engravings must have been the workmanship of antediluvian man. The scientific investigation of the early history of man is yet in its infancy, but must be conducted on the principles now laid down for historians; these are expected to examine for themselves original documents, to inspect with their own eyes the lands to which their narratives relate and to view their antiquities,—not to recompile second-hand materials, without ascertaining their validity: we believe the writer who has told us that Bagdad existed in the time of Nebuchadnezar, when we learn that bricks, impressed with the name of this monarch, are extracted from foundations of that city.

We may envy these authors their advantages, but here we cannot avail ourselves of their privileges. But let us do what we can to diminish the gap between us.

We need not hope to adorn our building with veritable marbles or bronzes from Greece and Italy, or winged bulls from the banks of the Tigris or Euphrates, yet repro-

ductions of many of the most marvellous feats of antiquity are procurable at no very great cost, whilst if even these should unfortunately be beyond our means, there still remains to us the power of obtaining, in photography, *facsimile* representations of most great works of art; thus, to some extent, though not in its full perfection, bringing home to ourselves ocular proof of their existence and appearance.

It has been well said that "the proper study of mankind is man," but man, in all ages, and under all conditions, prehistoric, ancient, modern, civilized, and savage—not that I have a word to say in disparagement of natural science. If we then, for ourselves and children, really desire to derive the greatest advantages from our possessing a building capable of displaying multifarious human productions, and in this way taking a foremost position as an educational institution, we require to place together the means for comparing the works of man from his earliest existence down to the present day—the rude attempts of primeval man in fashioning himself an implement, through successive modifications, to the complex machinery of the modern engineer, with specimens of art at various epochs, so as to mark the progress of human civilization; that thus, learning the status of man in the past, realizing his position at the present, we may be the better enabled to frame for ourselves that future which a beneficent Providence has left so materially in the power of ourselves.

1. "The Study of Statistics," by F. J. Moss.

2. "Descriptions of new Species of *Coleoptera*," by Capt. T. Broun.

ABSTRACT.

This paper named a new genus and twelve species, the descriptions of which will appear in a complete catalogue of the New Zealand Coleoptera, which the author is now engaged in preparing for publication.

3. "Notes on the Fertilization of *Glossostigma*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 358.)

SECOND MEETING. 25*th June*, 1877.

R. C. Barstow, President, in the chair.

New Members.—W. J. Cochrane, J. Cunningham, H. A. C. Fergusson, J. B. Graham, J. Hardie.

1. Mr. Ewington spoke at some length in reference to Mr. Moss's paper on "The Study of Statistics," read at the last meeting. In this utilitarian age men ask, "What is the use of Statistics?" but some evidence of their use may be inferred from the efforts which all European Governments are making, and the expense to which they are going to collect statistical information. Statistics being a collection of facts systematically arranged and registered, must prove useful to Astronomers, Geologists, Political Economists, and students of any department of knowledge, for statistics in the widest acceptation of the term embrace the whole field of learning. Where observations have to extend over a period of years before general principles can be deduced, as in Mr. Darwin's and Mr. Herbert Spencer's studies, statistics are invaluable; and the fact that the last-named writer has employed learned men to collect statistical information for this purpose shows that their utility is undoubted.

2. "Notes on the recent Earthquake Wave, as observed at the Bay of Islands," by James Macfarlane.

At Manawaora Bay, at 5 a.m. on May 11th, the sea rose six feet above the level of the highest spring tides, covering several stretches of low-lying land at the head of the bay, and causing considerable alarm to the settlers. About the same time the wave was felt very strongly in the Waitangi River. Some small cutters that were beating up the river had to drop anchor to avoid being washed ashore. At Russell, the tide ebbed and flowed at least seven times during the day, at irregular intervals. At Wairoa, just opposite Russell, at about 4 p.m., a wave rushed in with great force, covering at least ten yards of the strand above high-water mark; Mr. Ford's whale-boat was washed up by it and left high and dry. This wave receded immediately, but shortly afterwards again advanced, and remained at the same level as before for over ten minutes. During this time a large boat was loaded with potatoes, afloat all the time, and was just ready to shove off when the water again receded, leaving the boat aground several yards higher up than any boat has been in the recollection of Captain Haughton, who has been at the Bay of Islands since 1840. After this the tide came in and went out repeatedly, but never reached its former height.

3. "Notes on the Earthquake Wave as felt at Gisborne," by Captain Crisp, Harbour-master.

The first wave felt at Gisborne occurred between midnight and 2 a.m. on the morning of May 11th, and came in but slightly. Another wave came in about 4 a.m., rising about two feet. It being then high water, it had the appearance of an extraordinary swelling of the tide or some distant storm-wave. At about 7 a.m., however, when the tide had considerably receded, a very heavy wave rushed in with terrific force, and in the space of seven or eight minutes rose perpendicularly as many feet, and then as quickly receded, carrying with it about fifty yards of a sandy point in the harbour. No noise or any other warning was given of its approach. Similar waves occurred at 9 a.m., 11 a.m., 12·40 p.m., and 2·30 p.m. on the same day, each rising from two to three feet. On the morning of Saturday, the 12th, I was under the impression that the tidal disturbances had ceased, but later in the day they commenced again, and kept on at intervals of irregular duration until the morning of Monday, the 14th of May. During the whole period of the disturbances it was extremely difficult to know anything about the regular time of high water. It will also be observed that at first there was some little regularity in the intervals, but later on this disappeared.

4. "Description of a new Mollusk from Auckland Harbour," by T. F. Cheeseman, F.L.S.

5. "Descriptions of new Species of *Coleoptera*," by Capt. T. Broun.

This paper dealt exclusively with beetles of the sub-family *Colydiidæ*, of which one new genus and sixteen new species were described.

Third Meeting. 23*rd July*, 1877.

R. C. Barstow, President, in the chair.

New Members.—A. Aitken, C.E., J. O. Barnard, G. Black, W. H. Colbeck, H. E. Cotton, W. Elliott, J. James, W. McLaughlin, J. Howard, D. H. Mackenzie, G. Wade, F. Larkins, J. Newman, A. Whitaker.

1. "Early Records of Auckland," by His Honour Mr. Justice Gillies.

ABSTRACT.

The writer observed that the preservation of the early records of a country was of very great importance, as personal reminiscences, however valuable, are seldom entirely trustworthy, being unconsciously tinged by the views of the writer, or the part which he took in the events which he narrates. A great mass of the early official records were lost in the wreck of the "White Swan," many years ago; but there no doubt exist in the possession of private individuals many records of the early history of the colony, which are of little value to the individual, but which, in the course of a few years, will become of great interest and value to the community at large, if they were only collected together. The author stated that it was in the hope of stimulating others who possess such records to bring them together, and deposit them in the Museum where they would be accessible to the public, that he had prepared his paper; and as a first contribution towards this end, he now presented to the Institute a series of 54 documents, all more or less bearing on the early history of the colony.

2. "On the Presence of Nickel in the Auckland District," by J. A. Pond. (*Transactions*, p. 454.)

3. "Reason in the Lower Animals," by F. G. Ewington.

A discussion arose, in which Dr. Purchas, Col. Haultain, Mr. Moss, and others took part.

FOURTH MEETING. *20th August*, 1877.

R. C. Barstow, President, in the chair.

New Members.—G. B. Beere, W. Buchanan, P. Darby, W. Dowden, T. Montgomery, R. F. Sandes, T. G. Sandes, A. T. Urquhart, D. C. Wilson.

The Secretary read the list of donations to the Museum and Library since the last meeting.

1. "Note on the Discovery of Moa Remains at Awitu," by A. Mactier.

ABSTRACT.

The remains in question, consisting of a pair of tibiæ and metatarsi, together with a few phalanges of the foot, were stated to have been found while deepening a drain running through a small swamp of about 200 acres in extent, situated immediately behind the sand-hills on the West Coast, and about six miles to the south of the entrance to the Manukau Harbour. The bones were embedded in a blue sandy clay, about six feet from the surface. The swamp was stated to have been partly drained by the Maoris at some remote period, for the lines of their old drains could still be traced in some places.

Mr. Cheeseman said that the bones appeared to be referable to Professor Owen's *Dinornis giganteus*.

2. "Notes on a Deposit in the Shaft of the Pumping Association, Grahamstown, Thames," by G. Black. (*Transactions*, p. 456.)

A long discussion then ensued, in which Messrs Stewart, Goodall, J. B. Russell, and Dr. Purchas took part.

3. "Descriptions of new Species of *Coleoptera*," by Capt. T. Broun.

This paper contained descriptions of new species belonging to the families *Anthribidæ*, *Aphodiadæ*, and *Rhysodidæ*.

4. "Tewkesbury," by J. Adams, B.A.

This was a review of the period of English History immediately following the battle of Tewkesbury.

5. Dr. J. L. Campbell read some interesting personal reminiscences of the early history of Auckland, entitled "Auckland in 1840, and how we lived then," and "Auckland's first native alarm, an episode of January, 1841."

FIFTH MEETING. 22nd October, 1877.

R. C. Barstow, President, in the chair.

New Members.—W. Felkin, F.R.G.S., A. Heslop, A. Spicer, T. Whitson.

1. "Descriptions of new Species of *Coleoptera*," by Captain T. Broun.

This paper dealt exclusively with beetles of the families *Scaphidiidæ*, *Histeridæ*, *Bostrichidæ*, *Ptinidæ*, *Drilidæ*, *Diaperidæ*, *Cerambycidæ*, *Lamiadæ*, and *Chrysomelidæ*. Two genera and nineteen species were indicated as new. Some interesting information as to the habits of three species of *Bostrichidæ* was also given, and the author drew attention to the serious nature of their ravages in *Fagus* timber.

2. "Notes on the *Aphodiadæ* of New Zealand," by Capt. T. Broun.

This family of beetles was stated to have seven representatives in New Zealand—two of which were now described for the first time. All the specimens of the five species collected by the author were found under stones and logs, and were certainly not coprophagous in their habits as is uniformly the case with the European species.

3. "Descriptions of two new Mollusks from Auckland Harbour," by T. F. Cheeseman, F.L.S.

The species described were *Pleurobranchus ornatus* and *Aclesia glauca*. Coloured drawings of both were exhibited.

4. "Notes on a branched Nikau Tree," by S. Percy Smith. (*Transactions*, p. 357.)

5. "On the Disappearance of the Small Birds of New Zealand," by D. C. Wilson. (*Transactions*, p. 239.)

Mr. Firth entirely agreed with the remarks made by the author in reference to the operations of the Acclimatization Societies. Of late years quite a howl had been raised against the Auckland Society for its introduction of sparrows, greenfinches, chaffinches, etc., and it had been even roundly stated that the skylark had turned out an undesirable colonist. He had no sympathy with such statements; and believed that they rested on very slender foundations. He would admit that at a certain season of the year the sparrows and chaffinches might take a little grain, or that the blackbirds might help themselves to strawberries and cherries; but the fact remained that for eight months out of the twelve neither grain nor fruit could be obtained, and that then the birds must depend on insects for their existence. The small amount of evil done was conspicuous, and was consequently talked about and magnified, while the much larger amount of good performed was in a great measure hidden from view, and as a rule altogether escaped notice. Some years ago a similar outcry was set up in England, and by means

of sparrow clubs and similar institutions a wholesale slaughter of the smaller birds took place. But it soon became evident that as the birds decreased the insects increased, and he was happy to say that public opinion was fast undergoing a change, as was evidenced by the Small Birds Protection Act. Here in New Zealand, where the native birds were evidently unable to accommodate themselves to the changed conditions brought about by the advent of the European settlers, and were fast diminishing in numbers, it was almost a public duty to introduce others to take their place and perform their work; and he felt certain that ultimately the colony would thank the Acclimatization Societies for having taken the matter up.

Mr. Barstow agreed with much that the author had advanced, but could not assent to the view that the rat was the sole enemy of the New Zealand birds. He had long been of opinion that the introduction and spread of the honey-bee had much to do with the disappearance of the honey-eating species, such as the korimako. It was a common statement among the Maoris that the bees had appropriated the honey on which the korimakos fed, and had thus absolutely starved the birds to death. By many people the rat was credited with being the cause of the extinction of the native quail, which bred on the ground, and (so ran the story) was especially liable to have its eggs or young taken. But the same reasoning should apply still more strongly to the case of the pihoihoi, or ground lark, which nevertheless still very fairly maintained its numbers.

6. "Technical Education," by J. C. Firth.

The author stated that he had been induced to bring this matter under the notice of the Institute in consequence of the perusal of an excellent report issued by the Minister of Education for Victoria. After reading some extracts from this report, Mr. Firth offered some verbal remarks of his own as to the system of technical education now widely established in Germany, and recommended its introduction, in a modified form, into New Zealand.

A discussion arose, in which the Chairman, Col. Haultain, Mr. Mitford, and the author took part.

7. "Notes on blowing up Snags in the Waikato River with Dynamite," by R. R. Hunt. (*Transactions*, p. 161.)

This paper, which was fully illustrated with plans and diagrams, was read by Mr. Firth in the absence of the author.

Sixth Meeting. 19*th November*, 1877.

R. C. Barstow, President, in the chair.

1. The following letter, addressed by Capt. G. Mair, F.L.S., to Mr. Cheeseman, was read:—

"By cutter 'Leah' I send you a branch of a marine plant called by the natives Totaramoana or Rimumoana. It was brought up from thirty-five fathoms at Whale Island, where it is very abundant on the Hapuka fishing grounds. In the old days, before the introduction of iron, this plant was much prized by the natives, who dredged for it to make their fishing-hooks from. They bent it when green into the required shape, which it retained when dry and became as hard as ebony. Several hundred pounds weight of fish were caught on these hooks. When taken out of the water the plant was covered

with numbers of star-fish with long radiating arms, each twelve or fifteen inches long; these have now dried up quite small. You will see a cluster of rare little shells on the stem covered up with sponges. These shells are only found in deep water."

The specimen alluded to by Capt. Mair was exhibited.

2. "The *Curculionidæ* of New Zealand," by Capt. T. Broun.

Capt. Broun stated that the *Curculionidæ* now known to inhabit New Zealand numbered 114 species, distributed among forty-six genera. Of this number one genus and thirty species were now described as new for the first time.

3. "The New Zealand *Heteromera*," by Capt. T. Broun.

Thirteen species were indicated as new.

4. "Description of a new Species of *Polypodium*," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 356.)

5. "Notes on the firing of Torpedoes by Electricity," by J. A. Pond. (*Transactions*, p. 164.)

Annual General Meeting. 18*th February*, 1878.

R. C. Barstow, President, in the chair.

New Members.—T. Bennett, W. A. Brett, Sir Robert Douglas, Bart., M.H.R., W. P. Gordon, A. J. Hunter, W. W. Mitchell, J. P. Walker, F. A. White.

The Secretary read the minutes of the last annual meeting, held on 19th February, 1877.

ABSTRACT OF ANNUAL REPORT.

During the year six meetings were held, at which 24 papers were read. Since the last annual meeting 48 new members have been elected, the total number on the register of the Society now being 278. Numerous donations have been made to the Museum, but from the want of funds it has been impossible to supply cases in which to exhibit them to the public. Arrangements have been made by the curator for interchanges with the chief British and European Museums, and several valuable collections have been already received. The retiring Council recommend that an attempt should be made to obtain a landed endowment for the Institute, its present revenue being insufficient to maintain the museum and library in an efficient state.

The balance sheet showed the total receipts to be £498 4s. 0d. (including a balance of £80 19s. 8d. from last year. The expenditure amounted to £423 7s. 4d., leaving a balance in hand of £74 16s. 8d.

Election of Officers for 1878:—*President*, T. Heale; *Council*—R. C. Barstow, The Rev. J. Bates, J. L. Campbell, M.D., J. C. Firth, His Honour Mr. Justice Gillies, The Hon. Col. Haultain, G. M. Mitford, J. A. Pond, The Rev. A. G. Purchas, M.R.C.S.E., J. Stewart, M. Inst. C.E., F. Whitaker; *Auditor*—T. Macffarlane; *Secretary and Treasurer*—T. F. Cheeseman, F.L.S.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. *5th April*, 1877.

Professor von Haast, F.R.S., President, in the chair.

New Members.—W. A. Willis, The Rev. T. Flavell.

The President read his opening address. (*Transactions*, p. 87.)

Second Meeting. *4th May*, 1877.

Professor von Haast, F.R.S., President, in the chair.

New Members.—C. C. Howard, J. Holloway.

By permission, Mr. H. Czerwonka read a paper on the "Drainage of Christchurch."

Third Meeting. *14th June*, 1877.

R. W. Fereday in the chair.

New Members.—R. Parker, A. Carrick, The Rev. J. S. Smalley.

Fourth Meeting. *5th July*, 1877.

Professor von Haast, F.R.S., President, in the chair.

No papers were read.

Fifth Meeting. *2nd August*, 1877.

Professor von Haast, F.R.S., President, in the chair.

New Member.—W. Izard.

"Supplementary Description of Species or Varieties of *Chrysophani (Lepidoptera Rhopalocera)* inhabiting New Zealand," by R. W. Fereday, C.M.E.S.L. (*Transactions*, p. 252.)

Sixth Meeting. *6th September*, 1877.

Professor von Haast, F.R.S., President, in the chair.

"Sketch of the Traditional History of the South Island Maoris," by the Rev. James W. Stack. (*Transactions*, p. 57.)

SEVENTH MEETING. *4th October*, 1877.

Dr. J. S. Coward in the chair.

New Member—A. C. Baines.

1. "On the Influence of the Earth's Rotation on Rivers," by A. C. Baines. (*Transactions*, p. 92.)

2. "Sketch of the Traditional History of the South Island Maoris," (second paper), by the Rev. J. W. Stack. (*Transactions*, p. 57.)

ANNUAL GENERAL MEETING. 1*st November*, 1877.

New Member—H. Lee.

ELECTION OF OFFICERS FOR 1878:—*President*—Professor von Haast, F.R.S.; *Vice-presidents.*—The Rev. J. W. Stack, Professor Cook; *Council*—Professor Bickerton, Dr. Powell, W. M. Maskell, R. W. Fereday, Dr. Coward, G. W. Hall; *Hon. Treasurer*—John Inglis; *Hon. Secretary*—J. S. Guthrie.

Resolved—That in future the subscription be one guinea per annum, without entrance fee, dating from 1st November.

Resolved—That the Council be requested to take into early consideration the holding of periodical scientific excursions and to arrange for the same.

Resolved—That the Council revise the rules and report to a special meeting in December.

ABSTRACT OF ANNUAL REPORT.

The Council state that the number of members has been maintained. Nine new members have been elected, four of whom have fulfilled the condition of election, and are entitled to the privileges of membership.

Owing to various circumstances, fewer papers have been read this session than in former years; but the Council have reason to expect that next session will be a more productive one, the more so as a microscopical section has been formed, several of the members of which are pursuing original research.

The Council, this year, instead of making arrangements for holding the usual annual *conversazione*, accepted an invitation from the Board of Governors of the Canterbury College to assist that institution in arranging an Art Exhibition in the Museum buildings on the occasion of the opening of the Canterbury College buildings. The president, Professor von Haast, acted as superintendent of the Exhibition. The Exhibition was a thorough success. It was opened the 7th June in the presence of his Excellency the Governor, and was closed on 16th June, having been visited during that time by about 80,000 people.

The Treasurer's report showed a balance in hand of £160 14s. 8d.

SPECIAL MEETING. *6th December*, 1877.

Professor von Haast, President, in the chair.

New Members.—Rev. G. Cotterill, Rev. E, G. Penny, H. Czerwonka, J. Tyeth Hart.

The rules as revised by the Council were submitted, and after slight amendment adopted.

1. "Description of new Genera and Species of *Psychidæ*," by R. W. Fereday, C.M.E.S.L. (*Transactions*, p. 260.)

2. "Notes on Ferns," by T. H. Potts. (*Transactions*, p. 358.)

OTAGO INSTITUTE.

First Meeting. *5th June*, 1877.

The Right Rev. Bishop Neville, President, in the chair.

New Members.—A. Hill Jack, Rev. C. S. Ross, G. S. Duncan.

1. "Notes on the New Zealand *Myriopoda* in the Otago Museum," by Professor F. W. Hutton. (*Transactions*, p. 288.)

2. "On the Habits of the New Zealand Grayling *(Prototroctes oxyrhynchus)*," by J. Rutland; communicated by Prof. Hutton. (*Transactions*, p. 250.)

Second Meeting. *19th June*, 1877.

The Right Rev. Bishop Neville, President, in the chair.

New Members.—R. Paulin, G. E. Eliott, A. Montgomery, B. Throp, P. S. Hay, T. Forrester, Dr. Wilkins.

Professor Black gave a lecture on "The Earth a Cinder."

Third Meeting. *3rd July*, 1877.

R. Gillies, Vice-president, in the chair.

1. Professor Hutton explained Schivendener's Theory of the Nature of Lichens.

2. Professor Hutton read a note on a Fungus-penetrating Nostoc.

Fourth Meeting. *17th July*, 1877.

W. N. Blair, Vice-president, in the chair.

Professor Macgregor gave a lecture on Mental Physics.

Fifth Meeting. *7th August*, 1877.

The Right Rev. Bishop Neville, President, in the chair.

New Members.—Professor Scott, J. Marshall.

1. "The Dunedin Fish Supply," by P. Thomson. (*Trans.*, p. 324.)

2. "Second Note on the Maori Rat," by Professor F. W. Hutton. (*Transactions*, p. 288.)

SIXTH MEETING. 28*th August*, 1877.

R. Gillies, Vice-president, in the chair.

Dr. Hocken gave a lecture on the Hot Springs of New Zealand.

SEVENTH MEETING. 11*th September*, 1877.

The Right Rev. Bishop Neville, President, in the chair.

New Member.—J. C. Hoyte.

"Notes on some Changes in the Fauna of Otago," by R. Gillies. (*Transactions*, p. 306.)

EIGHTH MEETING. 25*th September*, 1877.

The Right Rev. Bishop Neville, President, in the chair.

New Member.—H. S. Fish, junr.

Professor Sale gave a lecture on Religion and the Drama.

NINTH MEETING. 9*th October*, 1877.

W. N. Blair, Vice-president, in the chair.

1. Professor Hutton exhibited a specimen of *Eudyptes schlegeli*, Finsch, obtained by Mr. R. Gillies, at Brighton, last March. This specimen, which was moulting, answered well to Dr. Finsch's description, except that it had no yellow line round the mandible.

2. "On a new Species of Trap-door Spider from New Zealand," by the Rev. O. P. Cambridge, A.M., C.M.Z.S., Hon. Mem. N.Z. Inst. (*Transactions*, p. 281.)

3. "Description of Trap-door Spiders' Nests from California and from Western Australia in the Christchurch Museum," by R. Gillies, F.L.S. (*Transactions*, p. 301.)

4. "Contributions to the Conchology of New Zealand," by Professor F. W. Hutton. (*Transactions*, p. 293.)

5. "Experiments on the Lifting Power of Inclined Planes in Aerial Transit," by H. Skey. (*Transactions*, p. 170.)

6. "On the Introduction of the Tension Wheel in Aerial Transit," by H. Skey. (*Transactions*, p. 173.)

7. "On the Introduction of the Principle of the Gyroscope in Aerial Transit," by H. Skey. (*Transactions*, p. 176.)

Tenth Meeting. *23rd October*, 1877.

W. N. Blair, Vice-president, in the chair.

New Member.—A. Grant.

1. "Notes on some of the New Zealand Minerals belonging to the Otago Museum," by A. Liversidge, Professor in the University of Sydney. Communicated by Professor Hutton. (*Transactions*, p. 490.)

2. Professor Scott gave a lecture on the "Hand in different Animals."

Eleventh Meeting. *8th November*, 1877.

W. N. Blair, Vice-president, in the chair.

Mr. J. McKerrow was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of "The New Zealand Institute Act."

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with Statute IV.

Annual General Meeting. *17th January*, 1878.

The Right Rev. Bishop Neville, President, in the chair.

1. "Contributions to the Botany of Otago," by T. Kirk, F.L.S. (*Transactions*, p. 406.)

2. "On the Botany of the Bluff Hill," by T. Kirk, F.L.S. (*Transactions*, p. 400.)

3. "Notice of the Occurrence of *Juncus glaucus*, L., in New Zealand," by T. Kirk, F.L.S. (*Transactions*, p. 393.)

4. "On *Lindsaya viridis*, Colenso," by T. Kirk, F.L.S. (*Transactions*, p. 396.)

ABSTRACT OF ANNUAL REPORT.

Since the last annual meeting 14 new members have joined and 21 resigned, making our number 224 members. Two members have become life members.

During the year the Institute has moved into permanent quarters in the Museum building.

During the year 12 meetings have been held, at which 14 papers were read, and 5 lectures delivered.

A considerable number of books have been added to the library.

The balance sheet showed the receipts for the year (including a balance of £32 10s. 2d.) to be £295 15s. 2d. The expenditure amounted to £232 5s. 0d., leaving a balance in the treasurer's hands of £63 10s. 2d. There is also to the credit of the Institute, in the Government Savings Bank, a sum of £43 18s. 5d.

Election of Officers for 1878:—*President*—W. N. Blair, C.E.; *Vice-Presidents*—Professor Hutton, W. Arthur, C.E.; *Council*—Professor Shand, G. Joachim, Professor Macgregor, Professor Scott, D. Petrie, E. Eliott, J. C. Thomson; *Hon. Sec.*—G. M. Thomson; *Hon. Treasurer*—H. Skey; *Auditor*—A. D. Lubecki.

The President delivered the following

ADDRESS.

It is difficult to gather exactly what may be expected from the retiring President of such an institution as the one which I now address. No doubt in the older institutions of other countries, which can boast of containing among their members numbers of individuals eminent for their attainments either in special departments of science or in a wide range of subjects, it is natural to expect that the President will have been selected on account of his ability to deal authoritatively with a particular subject, or to present a review of the latest results of scientific research and to point out their significance. It would be nothing less than presumption in such an one as myself to attempt either of these courses.

One who is debarred by the ceaseless pressure of other duties from conducting a course of independent enquiry, and who can do little more than skim the pages of a scientific journal amid the inconveniences of a coach journey or the difficulties of a lively railway carriage, though honoured by having been placed in the Presidential chair, can hardly on that account venture on so ambitious a flight.

Nor do I think that any sketchy reference to the subjects brought before the Society during the past year would be likely to be fraught with much either of interest or advantage. A considerable proportion of those present this evening heard those papers or lectures when read before the members of the Institution, for though it is true that in the early part of the session, when we first took possession of the new home of the Institute, many were slow to find their way into it, and the attendance was not so good as when the more centrally situated building was occupied, yet we have now so fully adopted our quarters in these halls of science that the fear is we have been too modest in our calculations of the space which would be required to give accommodation to the members of this Institute.

One of the considerations which led me to accept the office of President was that I felt that my having been selected for it was in some sort the assertion of a principle. Connecting the circumstance with the discussions which had shortly before prevailed, I did not think it vain or unjustifiable to conclude that, by this action, the members of the Institute generally were willing to have it understood that, whatever their opinions as to questions of detail and modes of operation, they, students of science as they are, acknowledged one great and beneficent First Cause, if I may not go further and believe that it is hereby testified that we have more still in common—viz., that, at least in its broad outlines and all-hallowing principles, the Christian Religion is held to be entirely consistent with all that nature has unfolded. I do not propose to make use of this occasion for the discussion of any of those questions which are held by many to bring the declarations of scripture into conflict with the declarations of the book of nature. Some of them I hold to be questions which ought never to have risen, which at least would never have attained the importance which has been attached to them if mutual respect and forbearance were more generally exercised, if there were not on the one hand oftentimes too strong an assertion of matters as being facts, which after all may be only

speculations resting on a more or less reasonable basis; and, on the other hand, oftentimes a too tenacious retention of what is merely traditional interpretation, or a clinging to quotations from uninspired records as though they were divine utterances. I think it more befitting to my present position however, that I should address myself especially to younger students of natural science, with a view to pointing out some of the mistakes which they perhaps are particularly liable to fall into, mistakes which no doubt further study would enable them to correct for themselves, but which often remain uncorrected very much because the studies are so fitfully pursued that it is only when some circumstance arouses a public interest in scientific subjects that their attention is drawn to them again. It may appear but a commonplace observation when I say that one of the first things to be guarded against is impatience of the drudgery needful to master even the alphabet of almost any branch of science. I mean more by this than that there is no royal road to learning, and my meaning extends to this, namely, that there is a great temptation to forsake the steady pursuit of knowledge along the more tedious pathways of careful observation and well-considered induction for the more attractive highways of fashionable theory. I am not alluding now to those whose chief object is to get a reputation for the possession of scientific knowledge careless as to the basis upon which that reputation may rest. It may suffice for such to read a review of them, to plunge hotly into a discussion probably with far more rashness of assertion than they dare to whom the subject had been long familiar. But I speak rather of this danger as besetting those who are sincere in their desire to get to the root of matters. It is a seductive error. It seems so much easier to discuss the merits of a theory than to plod along with the accumulation of facts, forgetting that we are not qualified to judge of the merits of a theory until we have a wide knowledge of the facts upon which it is based. It is that old error of the Aristotelian philosophy which the Baconians corrected. Dialectical skill instead of ascertained facts. Deductions from abstract and *a priori* propositions made to fit on to nature, instead of inductions from a multitude of observed phenomena leading up to conclusions of high probability. It is not wonderful that, in a population almost entirely occupied with pursuits which afford but little leisure, men should readily take the road which seems to be the shortest to the desired end, but it is a road which subdivides so often that its end is commonly confusion. Mind, I am distinguishing *theory* from *lawful induction*, and considering theory as something which men postulate for themselves, and a lawful induction to be a conclusion arrived at from the agreement of so many particulars as to make its value approach that of a general proposition. It is the business of the student of science to acquaint himself with these particulars. It is a common mistake to consider the dealer in theory a philosopher and to stigmatize the work of the plodding student as that of a mere recorder of observations; the former, however, is often a mere empiric, while the latter, if he be not a true philosopher, if he will but persevere is likely to become such because his well-stored mind can hardly fail to arrange his copious data; unbidden thoughts will come and form themselves into conclusions the value of which will be in proportion to his stock of knowledge, his judgment, his mental training, and his mental powers. Only let the philosophy come in its proper place, not first, but last. It will be understood that my remarks have special reference to the physical sciences.

A kindred, yet distinct danger is that of jumping to conclusions upon data, which, if not altogether unreliable, are often very partial. Should the fact or facts in view come in support of an opinion previously formed, some hobby of our own, what an almost irresistible temptation to build a wide-spreading superstructure upon a narrow basis! I

must be forgiven if I hint that this temptation is one into which not a few fall who cannot be said to be very juvenile observers. I will illustrate my meaning from the science of geology. How many imposing arguments we will say as to the duration of man upon the earth have been based upon such calculations as those made in regard to the length of time it would take to accumulate a certain thickness of river deposit over the bone which had been found, or the position of a bone in a bed of gravel. What room there is in such cases for a variety of circumstances not taken into the calculation, but which, nevertheless, may so affect the issue as to render the conclusion almost worthless. Take the former example. There are the considerations which arise from fluctuations in the force of the stream, the climatic conditions, the character of the material deposited, the likelihood of the pre-existence of swamps, etc., and yet we find the number of inches of mud which the observer found to have been deposited within a given time during his own opportunity of enquiry to be taken as the unit of measure; or if we have gravel beds and the like under our notice, especially if the country be a mountainous one, we have to take into the account—not only the even flowing stream we see in years of fair weather, and with its banks protected at all dangerous points by modern appliances to keep the stream to its appointed bounds—but the stream as it was when perhaps lower lying snows swelled its volume as they yielded to the summer sunshine, or primeval forests attracted a more copious rainfall higher up its course. In such cases resistless floods might bring down more material in a few hours than would be accumulated in years under the conditions which now prevail. A night might overwhelm a whole tribe of natives encamped by the stream in a destruction still more dire than that terrible fate which overtook the ill-starred settlers, but a year ago, in their peaceful homes at Motueka, the boasted happy valley. Numbers from Nelson went to be sorry witnesses of what they could not from mere reports believe, viz., that the little river, transformed into a torrent, had torn down from its banks such masses of detritus as to cover fields and gardens in a general ruin, in some instances to the depth of the fences which surrounded them. It might hereafter be concluded that the transport of so much material was the work of years.

Another very unreliable class of evidence is that derived from the fossils exhumed from the floors of caves; it is often almost impossible to say how many times these have been disturbed though the appearances may seem to betoken no intrusion. The finding of a broken tobacco pipe under circumstances which appeared indistinguishable from those under which the instruments and ornaments which had belonged to ancient Britons were obtained, was calculated to dispel conclusions which would otherwise have appeared sound. It was bad enough to discover that the tooth, at first fondly taken to be that of a young cave hyæna, was only that of a dog, but the other thing was not to be got over. Now let us suppose that instead of that instrument of vile purpose, which the ancient Britons could never have been so degenerate as to have used, the tooth of *Ursus speleus* had been turned up, the argument would have been thought undeniable that the ancient inhabitants of Derbyshire—for the cave of which I am speaking is in that county—had to do battle with that extinct animal. I am not saying that there is no evidence for the contemporaneity of the cave-bear with man, but showing how easy it is even for good observers to be deceived. The cave floor may be as completely hardened by the traffic of a multitude of feet within the last few years, during which excursionists have penetrated everywhere, as in a century or so when visits were only paid to such places under pressure of necessity as hiding places in times of trouble. The point upon which I am insisting is that under the inductive system, which is the plan scientists

must follow, matters must be looked at all round before an attempt is made to establish a conclusion. We have to arrive at something like a general proposition from particular ones, instead of the logically more certain process of deducing the particular from a general. The reason of this it is easy to see. In the physical sciences the particular premises are more within our cognizance than the general ones. Thus the two temptations, against which I have presumed to warn students, have their root in the same circumstance. To try to arrive at a scientific conclusion from a general theory is to try to get a certainty out of an uncertainty; and to hastily frame a general proposition out of a small array of observations, even supposing them to be correct enough in themselves, is to make the same mistake by an opposite method. An induction can never do more than justify a reasonable conviction of the mind, and afford the highest probability of the truth of the conclusion, but there is always the possibility of that conclusion being modified by the presentation of further particulars, beforetime unknown or neglected. You see, then, what a multitude of lines ought to converge before a positive assertion is ventured upon—in other words, before this or that is affirmed to be scientific fact. I have alluded, by way of illustration, to the question of the duration of man upon the face of the earth; I then used it in speaking of the quality of evidence, and of the happy knack some have of making a very little go a long way. I press the same question into my service in pointing out how frequently considerations which have an important bearing upon the subject in hand are passed by without fair consideration, possibly from a kind of intuition that they will prove to be lines which will not converge to the conclusion we would fain see established; it is so very hard to be quite unbiassed, and free from all party influences! In debates upon the question I have named, it has never appeared to me that sufficient attention has been given to the enormous possibilities within the period acknowledged by all. I am not now insisting upon the correctness of the most generally accepted reckonings in Bible chronology, nor am I entering upon the merits of the question I allude to; but speaking of time as an element in such questions, I think that no sufficient recognition is made of all that a thousand years may mean. Realize in mind the condition, say of Britain and Northern Europe generally, 1,000 years ago, with reference to the condition of its population, climate, forests, wild animals, and the like; go back then in mind 1,000 years before that again, and, repeating this process, I think it will be seen that, when enormous periods of time are glibly rolled off the tongue in relation to such questions, there is not unfrequently a failure to apprehend the full force of what is so easily dismissed, and perhaps, after all, it will be thought that the premises which may have been fairly established are not numerous enough, viewed in the light of other considerations, to enable anything like a positive assertion to be made.

I must say a few words upon that alluring snare of *over-systematizing* in scientific matters. It is so very satisfactory to be able to announce a law; it seems one step more towards reducing confusion to order, it seems to be getting something done and settled; but here again we may be only pushing our particular to a universal. A conclusion in geological science, for example, which is just enough when confined to one locality, is utterly fallacious when stretched out into universality. These remarks will apply, in my estimation, to such artificial arrangements as the division of the human period into the stone, the iron, and the bronze periods. Whatever justification there may be for such a division in a particular country, it cannot consistently with history be predicated in application to the world at large. Every day long-buried treasures are being brought to light which tell us that as far back as the historic eye can pierce there were nations who had attained a high degree of knowledge and of skill in the working of metals, and if to the testimony derived from the most ancient cities of Assyria or Greece we may

add a word on the subject from the most ancient written record in the world, it is to say that there lived, in the days when earth was very young, at least historically, a celebrated instructor in all works of brass and iron. So, too, it goes against the uniformity of this system when we observe that side by side with the civilization of our own day there are peoples who still make use of the flint arrow-heads and the stone hatchets supposed to be characteristic of an age long past. One may carry these illustrations further and say that there never were those periods of uniform action and uniform phenomena extending over the whole globe at the same time which would cause the same effects to be at the same time everywhere produced. I suppose no one will now assert that in the Carboniferous epoch coal was being spread at the same time over the whole surface of the globe like the several coats of an onion, or chalk in the Cretaceous, but it is not so well borne in mind that neither were the fauna or flora of those or any other periods uniformly scattered over the face of the earth in the past any more than they are now. When, for example, we say that the Saurians are characteristic of the Liassic period, we only mean that they were to be found in that period, in those climates, and under those conditions which were suitable for them. In other climates at the same time altogether different creatures might be found. Again, when it is said, as it is in Europe, that the Saurians disappear in the great gap which in that region is found to intervene between the Upper Cretaceous and Lower Eocene rocks, it by no means follows that they are not to be found much later in other parts of the world where there may be no such break in the series. In support of this we may refer to the fact of the existence in our neighbouring continent of Australia of so many marsupial animals, though this group is amongst the first to appear in the geological records of the mammalia, and has disappeared ages ago in many regions in which its fossil remains are most abundant. Of course no one will accuse me of arguing against all legitimate arrangement and grouping of ideas into systems, but my tirade is against the invention of systems for system's sake, for mere artistic effect and the like, and the burthen of my theme has been the inculcation of care, deliberation, and breadth of view in the investigation of the problems of nature. It is only thus we can hope to arrive at truth! Sincerity in the pursuit of herself, is what Truth first demands, but she will not often yield to sincerity alone. Faithfulness, large-heartedness, impartiality, and care, must go hand-in-hand to solicit her presence. We must seek her too from every quarter, for she dwells not within our circle only, thus are all sciences related to each other. All physical sciences—this is the smaller circle, and within it all, astronomy, chemistry, and the rest, besides their own inherent value, unite their lines of light in disclosing the history of the earth. But there are wider circles still, for metaphysics and theology, in spite of Positive Philosophers, will live while men have minds and spirits, and these sciences are related to the other as the mind is to the body, and the spirit to them both. The mysteries may take long unravelling; they will not be extinguished by denial. Let faith have her perfect work. To sciencist—earnest, true, and humble—and alike to theologian, I say, go on with your interpretations each in your proper sphere, and by your proper methods, and in God's name I bid you all success—"In your patience possess ye your souls."

HAWKE BAY PHILOSOPHICAL INSTITUTE.

FIRST ANNUAL GENERAL MEETING. *4th June*, 1877.

Robert Stuart in the chair.

ABSTRACT OF ANNUAL REPORT.

This Society was founded in September, 1874, and within a few weeks sixty members were enrolled. Of these, one—Mr. Catchpool—had died, and three had resigned, and there were thirteen new applicants for membership.

Owing to adverse circumstances no annual general meeting could be held before this, but the Council had met frequently, and ordered some of the best modern works on various branches of science, which were expected soon to arrive.

Several members had collected specimens of various kinds which they purposed presenting to the Institute, whenever a proper place was prepared in which to deposit them.

Regret was expressed at the inability of the Right Rev. Dr. Williams, Vice-president, to attend, through infirmity.

The Secretary had several papers in preparation to read to the Society, and his report concluded by pointing out the many advantages of belonging to such an Institution.

The total receipts since the foundation of the Society were £265 2s. 0d., including a grant of £100 from the late Provincial Council. The expenditure was £53 19s. 2d., leaving a balance to credit of £211 2s. 10d.

The thanks of the Society were directed to be recorded to the Honorary Secretary for his report.

A letter was read from the Rev. Dr. Williams, late Bishop of Waiapu, resigning his office of Vice-president, owing to infirmities.

ELECTION OF OFFICERS FOR 1877-78:—*President*—The Hon. J. D. Ormond, M.H.R.; *Vice-president*—Robert Stuart; *Council*—Messrs Holder, Kinross, Miller, Newton, Smith, Spencer, Colenso; *Hon. Secretary and Treasurer*—W. Colenso; *Auditor*—T. K. Newton.

New Members.—W. J. Birch, R. L. Colenso, P. Dolbel, A. Kennedy, A. Lascelles, R. D. Douglas McLean, A. McLeod, H. Nairn, J. Nairn, G. A. Oliver, J. Rochfort, F. Sutton, and G. Willis.

FIRST MEETING. *13th August*, 1878.

W. I. Spencer, M.R.C.S., in the chair.

1. "On the Day in which Capt. Cook took formal Possession of New Zealand," by W. Colenso, F.L.S. (*Transactions*, p. 99.)

2. "Notes on the Metamorphosis and Development of one of our large Butterflies *(Danais berenice)*, or a closely-allied Species," by W. Colenso, F.L.S. *(Transactions*, p. 276.)

A short discussion took place in which Dr. W. L. Buller took part.

8. "*Manibus Parkinsonibus Sacrum*—A brief Memoir of the First Artist who visited New Zealand; together with several little-known Items of Interest extracted from his Journal," by W. Colenso, F.L.S. (*Transactions*, p. 108.)

A cordial vote of thanks was passed and ordered to be recorded to the Hon. Secretary for his papers.

SECOND MEETING. 10*th September*, 1877.

There being only a few members present, owing to the inclemency of the weather, no papers were read.

THIRD MEETING. 8*th October*, 1877.

H. R. Holder in the chair.

The President, the Hon. J. D. Ormond, M.H.R., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the "New Zealand Institute Act."

1. "Notes, chiefly historical, on the ancient Dog of the New Zealanders," by W. Colenso, F.L.S. (*Transactions*, p. 135.)

The thanks of the meeting were unanimously accorded to the Hon. Secretary for his paper.

2. "On two indigenous Productions—Manganese and *Zostera marina*—which might be made fair Articles of Export," by J. A. Smith.

I beg to make a few remarks with regard to two exports from New Zealand which will repay the shipper.

The first is manganese, a mineral. It is found in France, Hungary, Brazil, Cornwall, and Devon, also in the North Island of New Zealand. A mine is now open at the Bay of Islands, New Zealand, with, I believe, success. The specimen produced is from that mine. It has been assayed by Mr. Tunny, and found to contain from 80 to 84 per cent of pure manganese. As to colour, it is found of a dark steel-grey, bluish, or iron-black. It is used for producing oxygen, chlorine, and chloride of lime, removing the brown and green tints in glass, in painting glass and enamel work, and for glazing and colouring pottery. In 1872, when in England, I visited the extensive Hebburn chemical works at Gateshead, on the Tyne, the property of Messrs Charles Tennant and Co. They occupy about 250 acres of land, of which about 13 acres are occupied by sulphuric acid chambers, which will give some idea of its vast extent. This is a branch establishment of the well-known St. Rollox chemical works in Glasgow belonging to the same firm. The principal reason for establishing these works on the Tyne was that they could get the chalk ballast brought by the colliers from London at 5s. per ton. Mr. Buchanan, the Manager of the Hebburn works, informed me that he would take any quantity of manganese of good quality that we could send from New Zealand at from £6 to £7 per ton. Besides sending it to London in our wool ships as ballast it might be shipped to Liverpool and Glasgow for the extensive chemical works in the vicinity of

both ports, and there is no reason why it should not be sent home also viâ Sydney and Melbourne.

Assuming that it could be shipped in New Zealand as ballast at from £2 to £3 per ton, the only expense after that would be discharging it in London into the colliers for Newcastle as ballast, the expense of which is 5s. per ton. This would leave a very good return to the shipper.

The second export is Algæ, *Zostera marina*, or Sea-grass.

It is found in France, Spain, and the Morocco Coast. In New Zealand it is found in large quantities on the coasts of the North Island.

It is used in England extensively for stuffing mattrasses, carriages, furniture, etc.; the demand is unlimited; the value in London is from £7 10s. to £10 per ton, and more if clean and free from sand.

The specimen produced is from the vicinity of Auckland.

Specimens of ores of Manganese, and of the plant *Zostera marina*, were exhibited by the author.

A short discussion arose on both of those papers.

Fourth Meeting. • *5th November*, 1877.

R. Stuart, Vice-president, in the chair.

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with Statute IV.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

The following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations for 1877.

TABLE I.—Temperature of the Air, in shade, recorded at the Chief Towns in the North and South Islands of New Zealand, for the year 1877.

Place.	Mean Annual Temp.	Mean Temp. for (Spring) Sep., Oct., Nov.	Mean Temp. for (Summer) Dec., Jan., Feb.	Mean Temp. for (Autumn) Mar., Apl., May.	Mean Temp. for (Winter) June, July, Aug.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.
North Island.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui	61·6	60·8	67·9	63·9	54·1	16·4	51·0
Auckland	58·6	57·2	65·6	60·5	51·2	14·7	49·1
Taranaki	56·5	54·5	63·0	57·9	50·6	17·2	51·0
Napier	59·0	58·5	67·3	59·2	51·2	14·8	54·0
Wanganui	55·1	53·8	63·6	55·6	47·5	21·0	56·0
Wellington	55·5	54·4	63·0	55·7	48·3	14·0	50·5
Means, etc., for North Island	57·7	56·5	65·0	58·8	50·4	16·3	56·0
South Island.							
Nelson	55·2	54·9	63·4	55·7	47·2	21·7	55·0
Cape Campbell ..	56·9	55·8	63·7	57·7	50·6	11·1	44·6
Christchurch ..	52·3	52·9	61·5	51·2	43·7	19·5	62·7
Hokitika	52·2	51·2	59·4	53·1	45·3	14·3	49·3
Dunedin	50·3	50·6	57·8	49·5	43·3	14·3	53·0
Queenstown ..	49·3	50·1	58·7	48·9	39·5	15·8	58·3
Southland	*50·4	49·5	57·5	52·2	43·1	19·1	63·0
Means, etc, for South Island	52·4	52·1	60·3	52·6	44·7	16·5	63·0
Means for North and South Islands	55·0	54·3	62·6	55·7	47·5	16·4	63·0

* For 11 months only.

TABLE II.—Barometrical Observations.—Rainfall, etc., recorded for the year 1877.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
NORTH ISLAND.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
Mongonui ..	30·016	1·428	·440	79	54·470	5·3
Auckland	30·021	1·370	·395	79	40·375	6·0
Taranaki	30·003	1·420	·360	77	52·000	6·3
Napier	29·973	1·318	·357	69	33·450	2·7
Wanganui ..	30·028	1·350	·314	71	43·700	5·0
Wellington ..	29·965	1·647	·386	76	51·925	5·1
Means for North Island	30·001	1·421	·367	75	45·986	5·0
SOUTH ISLAND.						
Nelson	29·874	1·581	·337	76	48·520	4·8
Cape Campbell ..	30·020	1·390	·376	80	16·070	6·3
Christchurch ..	29·931	1·820	·296	74	23·720	5·9
Hokitika	29·949	1·725	·340	85	136·660	5·5
Dunedin	29·700	1·639	·279	76	37·460	5·7
Queenstown ..	29·848	1·740	·285	66	35·590	5·5
Southland ..	29·816	1·800	—	—	43·150	6·9
Means for South Island	29·877	1·670	·310	76	48·738	5·8
Means for North & South Islands	29·939	1·545	·338	75	47·362	5·4

TABLE III.—Wind for 1877.—Force and Direction.

Place.	Average Daily Velocity in Miles.	Number of Days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.*
NORTH ISLAND.										
Mongonui	155	32	47	47	32	38	69	54	46	0
Auckland	269	31	42	23	23	49	114	55	28	0
Taranaki	232	33	25	22	93	10	98	30	54	0
Napier	232	33	77	14	33	56	75	44	20	18
Wanganui	242	4	13	4	49	1	43	33	128	90
Wellington	216	6	28	5	102	1	23	5	194	1
SOUTH ISLAND.										
Nelson	164	37	56	33	85	14	86	4	50	0
Cape Campbell	376	5	1	2	57	81	6	53	125	35
Christchurch	164	4	128	28	13	7	149	11	25	0
Bealey	191	64	28	6	35	9	15	12	120	81
Hokitika	—	32	45	106	23	2	82	35	40	0
Dunedin	170	14	47	21	4	26	103	48	5	97
Queenstown	100	11	12	0	12	8	33	27	129	133
Southland	198†	28	62	31	10	5	74	99	56	0

* These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

† For 10 months only.

TABLE IV.—Bealey—Interior of Canterbury, at 2104 feet above the sea. 1877.

Mean Annual Temp.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degrees.	Degrees.	Degrees.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10
46·0	15·8	71·0	29·715*	1·434	·205	65	106·414	5·0

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1877.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Taranaki ..	..	..	..	..	8	..	..	..	..	..	..	..	1
Napier ..	..	..	..	..	..	..	..	..	25*	25*	..	..	2
Taupo ..	..	..	..	..	..	..	23†	..	..	..	..	8*	2
Manawatu ..	..	5*	..	..	..	..	..	..	..	..	..	..	1
Wanganui ..	..	7	..	..	..	..	..	11	..	..	..	..	2
Wairoa ..	..	..	..	..	..	..	..	..	..	25*	..	..	1
Foxton ..	..	..	..	..	..	..	..	..	22*	..	..	..	1
Wellington	10*	9, 10	..	..	..	..	4, 16	11	15, 22* 29	10	6, 7	..	12
Blenheim ..	..	..	..	..	..	..	..	..	22*	..	..	..	1
Picton.. ..	..	..	..	..	..	..	..	..	22*	..	..	..	1
Havelock ..	..	..	..	..	..	..	..	..	22*	..	..	..	1
Nelson ..	..	..	..	..	..	..	4*	..	..	9*	..	..	2
Westport ..	..	..	..	..	..	..	4*	..	..	..	..	..	1
Lyttelton ..	..	2	..	..	..	..	..	..	..	..	..	..	1
Rakaia ..	..	..	..	..	..	..	..	..	16	..	..	..	1
Dunedin ..	..	..	..	..	..	..	..	..	..	9*	..	..	1
Port Chalmers	..	..	..	..	..	..	..	..	..	1	..	..	1
Lawrence ..	..	..	..	..	..	..	..	..	..	9*	..	..	1
Queenstown ..	..	..	..	..	2	..	..	14	..	..	..	..	2
Upper Shotover	..	..	..	13*	..	..	..	..	..	..	..	..	1
Roxburgh ..	..	..	..	..	..	..	..	..	..	9*	..	..	1
Balclutha ..	..	..	..	..	..	..	..	..	..	9*	..	..	1
Palmerston Sth.	..	..	..	..	..	..	..	..	..	9*	..	..	1
Oamaru ..	..	..	..	..	..	..	..	..	..	9	..	..	1
Naseby ..	..	..	..	..	..	..	..	..	..	9*	..	..	1
Timaru ..	..	..	..	..	..	..	..	..	..	10	..	..	1
Waimate ..	..	..	..	..	..	..	..	..	..	10	..	..	1
Kaiapoi ..	..	..	..	..	..	..	..	..	..	..	21	..	1
Rangiora ..	..	..	..	..	..	..	..	..	..	..	21	..	1

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart;* those with a dagger as *severe shocks*. The remainder were only slight tremours, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. This table is therefore not reliable so far as indicating the geographical distribution of the shocks.

TABLE VI.—COMPARATIVE ABSTRACT for 1877, and previous years.

STATIONS.	Barometer. Mean Reading.	Barometer. Extreme Range.	Temperature from Self-registering Instruments read in Morning for Twenty-four hours previously. Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Mean Temp. on Grass.	Computed from Observations. Mean Elastic Force of Vapour.	Mean. Deg. of Moisture. (Saturation=100.)	Rain. Total Fall in Inches.	No. of Days on which Rain fell.	Wind. Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and date.	Cloud. Mean Amount. (0 to 10).
North Island.														
Mongonui	30·016	1·428	61·6	16·4	51·0	165·0	—	·440	79	54·470	172	155	528, 4 Feb.	5·3
Previous 11 years ...	29·943	—	60·5	—	—	—	—	§ ·423	§76	54·719	166	—	—	—
Auckland	30·021	1·370	58·6	14·7	49·1	156·0	27·0	·395	79	40·375	203	269	759, 10 May	6·0
Previous 13 years ...	29·939	—	59·6	—	—	—	—	·411	79	44·651	187	—	—	—
Taranaki	30·003	1·420	56·5	17·2	51·0	147·0	27·0	·360	77	52·000	173	232	640, 10 Feb.	6·3
Previous 13 years ...	29·936	—	57·4	—	—	—	—	** ·372	**74	56·806	160	—	—	—
Napier	29·973	1·313	59·0	14·8	54·0	138·0	30·0	·357	69	33·450	108	232	900, 10 May	2·7
Previous 9 years ...	29·924	—	58·3	—	—	—	—	·368	75	36·500	109	—	—	—
Wanganui ..	30·028	1·350	55·1	21·0	56·0	150·0	24·0	·314	71	43·700	161	242	797, 27 Oct.	5·0
Previous 5 years ...	30·042	—	55·9	—	—	—	—	·332	72	40·531	130	—	—	—
Wellington ..	29·965	1·647	55·5	14·0	50·5	158·0	26·0	·336	76	51·925	151	216	700, 4 Nov.	5·1
Previous 13 years ...	29·901	—	54·7	—	—	—	—	·332	72	51·647	158	—	—	—
South Island.														
Nelson	29·874	1·581	55·2	21·7	55·0	—	—	·337	76	48·520	85	164	386, 17 April	4·8
Previous 13 years ...	29·895	—	55·5	—	—	—	—	·363	74	63·657	89	—	—	—
Cape Campbell ..	30·020	1·390	56·9	11·1	44·6	—	—	·376	80	16·070	81	376	1,012, 27 Jan.	6·3
Previous 3 years ...	29·981	—	58·3	—	—	—	—	·365	74	20·866	98	—	—	—
Christchurch ..	29·931	1·[illegible]20	52·3	19·5	62·7	156·3	11·2	·296	74	23·720	117	164	566, 5 Nov.	5·9
Previous 13 years ...	29·881	—	53·4	—	—	—	—	·326	77	25·873	118	—	—	—
Bealey*	29·715	1·434	46·0	15·8	71·0	151·0	7·0	·205	65	106·414	163	191	552, 10 Nov.	5·0
previous 9 years ...	29·850	—	46·5	—	—	—	—	·259	79	97·681	172	—	—	—
Hokitika	29·949	1·725	52·2	14·3	49·3	156·0	20·0	·340	85	136·660	214	—	—	5·5
Previous 11 years ...	29·929	—	52·7	—	—	—	—	·346	85	114·228	‖186	—	— [18 Sep.	—
Dunedin	29·700	1·639	50·3	14·3	53·0	125·0	26·0	·279	76	37·460	134	170	680, 10 May, and	5·7
Previous 13 years ...	29·835	—	50·6	—	—	—	—	·281	74	33·833	163	—	—	—
Queenstown ..	29·848	1·740	49·3	15·8	58·3	—	—	·235	66	35·590	130	100	293, 1 Sept.	5·5
Previous 5 years ...	¶29·898	—	50·7	—	—	—	—	·246	66	30·811	118	—	—	—
Southland ..	29·816	1·800	†50·4	19·1	63·0	157·0	—	—	—	43·150	222	‖198	571, 27 Oct.	6·9
Previous 12 years ...	29·805	—	‡49·9	—	—	—	—	‡ ·274	‡75	45·119	170	—	—	—

* 2,104 feet above sea level. † For 11 months. ‡ Previous 8 years. § Previous 10 years. ‖ For 10 months. ¶ Previous 4 years. ** Previous 12 years.

NOTES ON THE WEATHER DURING 1877.

JANUARY.—Wet, stormy, and unpleasant weather generally experienced throughout; wind prevailing from westward, and frequent thunder-storms. Earthquake reported by observer at Wellington on 10th, at 9·58 p.m., sharp, from S.E.

FEBRUARY.—During the first half of month the weather throughout was exceedingly wet and stormy, with thunder; floods occurred at several places throughout the colony; the latter part was fine generally. Earthquakes reported by observers at Wellington on 9th, at 6·49 p.m., slight, 4 secs., from S.E., and on 10th, at 8·49 a.m., slight, 2 secs., from E.; at Manawatu, 5th, 10·24 p.m., sharp, preceded by slight noise; Governor's Bay, 2nd, at 10.10 p.m., S.W.; Wanganui, night of 7th, loud rumble.

MARCH.—With the exception of the heavy fall of rain at Mongonui between the 6th and 17th, the weather throughout during this period was exceedingly fine, with a remarkably small rainfall and generally light winds.

APRIL.—With few exceptions the weather during this period was fine for time of the year, with little rain, and no storms of any violence. The temperature was, however, rather below the average throughout. The Queenstown observer reports a smart shock of earthquake in neigbourhood of Skipper's, Upper Shotover, about the 13th.

MAY.—With few exceptions the weather has been very wet and boisterous throughout the month, accompanied by thunder and hail storms, and excessive falls of rain; the wind was principally westerly; the barometer and thermometer readings were below the average. Earthquakes were reported by observers at Taranaki on 8th at 7·20 a.m.; and at Queenstown on 2nd, slight. A tidal disturbance was observed at many of the stations on the East Coast on the 11th. A brilliant meteor was observed in the extreme North on the 11th, and one at Lyttelton on the 15th.

JUNE.—Except in the interior and on the West Coast of the South Island, the rainfall has been small for the time of year, and on the whole fine winter weather was experienced.

JULY.—Very fine weather generally throughout for time of year; small rainfall and moderate winds; exceeding high barometric pressure; temperature below the average. Earthquakes felt at Wellington, 4th, at 4·27 p.m., N. to S., slight; and on 16th, slight double shock, between 10 and 11 p.m.; at Nelson, on 4th, at 4·20 p.m., sharp, and at Westport, at 3·30 p.m., smart.

AUGUST.—About the average weather for the time of year; the rain at most stations less than usual for this month, and no violent storms occurred; the temperature rather high. Earthquakes felt at Wanganui, on 11th, at 6·30 a.m., slight; Wellington, same date, and about same hour, slight; at Queenstown, a slight shock reported on 14th, at 6 a.m.

SEPTEMBER.—Very small rainfall during this month as compared with that for same period in former years; the atmospheric pressure was generally higher, and the temperature about the average on the whole; some strong winds were experienced from westward, but generally the weather for the time of year was fine. Earthquakes were felt at Wellington, on the 15th, between 8 and 9 a.m., slight; on 22nd, at 4·40 p.m., two smart shocks with rumbling noise; and on 29th, at 1·50 a.m., a slight movement: also at Rakaia, on 16th, a shock reported.

OCTOBER.—Generally fine and dry early part of month, but during latter half, at most of the stations, wet unpleasant weather was experienced, with much snow and thunder, and some strong S.W. gales. Earthquakes at Napier, on 25th, at 8·40 p.m., smart; at Wellington, on 10th, slight shock at 8·53 p.m.; at Timaru and Waimate, on 10th, at night; at Dunedin, on 9th, shock reported.

NOVEMBER.—During early part of month strong westerly gale experienced at almost all stations, accompanied at most places with heavy rain, hail, and thunder, causing floods; the latter part of month generally fine and pleasant; except at one or two localities the rain was under the average. Earthquakes felt at Wellington, on 6th, at 9·10 a.m., slight; and on 7th, at 8.21 p.m., slight; at Kaiapoi and Rangiora, on 21st.

DECEMBER.—Fine weather generally experienced during this month, although at some of the stations, especially in the South, the rain was in excess of average. Westerly winds prevailed, and on the 6th a storm from that quarter was felt at many places; the temperature was on the whole about the average. An earthquake at Taupo was reported by telegram on 8th, at 4·15 a.m., smart.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS

TAKEN AT DELANASAU, BAY OF ISLANDS, BUA, FIJI,

For the Year ending 31st December, 1877,

By R. L. HOLMES, F.M.S.

Latitude 16° 38' S. Longitude 178° 37' E.

Height above sea level, 77 feet; distance from sea, one mile.

[*Communicated to the New Zealand Institute.*]

1877.		Self-Registering Thermometers.				Rainfall.				
		Mean temp. in shade.	Max. temp.	Min. temp.	Mean daily range.	Total Amount in Inches.	Greatest daily fall.	Number of days it fell.	Hours of rain.	Average previous six years.
January ..	..	80·0	93·8	69·2	13·3	41·70	12·08	23	118	23·46
February	..	81·8	93·8	72·2	12·0	13·46	2·20	15	54	17·55
March ..	..	81·8	94·7	68·8	16·5	7·22	2·74	13	22	25·05
April ..	..	80·5	90·8	71·2	12·0	5·65	1·11	14	33	10·49
May ..	..	79·7	91·5	64·0	18·3	0·83	0·63	6	4	5·78
June ..	..	76·6	89·2	59 5	15·7	0·86	0·46	5	6	2·75
July ..	..	74·7	87·4	59·3	15·3	5·52	3·50	9	36	1·38
August ..	..	75·0	88·4	56·8	13·5	2·30	0·50	10	24	5·31
September	..	75·0	89·8	56·3	19·5	0·41	0·37	2	3	4·45
October ..	..	78·7	95·8	60·2	20·0	1·29	1·10	4	6	6·93
November	..	79·9	93·6	68·0	18·0	0·48	0·41	3	4	6·24
December	..	84·1	97·6	70·8	18·8	0·81	0·81	2	2	9·30
Year 1877	..	78·9	97·6	56·3	16·1	80·53	12·08	106	312	118·69
1876	..	79·3	97·0	60·0	16·3	91·36	5·73	135	388	—
1875	..	79·1	95·5	58·5	15·8	126·64	7·65	146	553	—
1874	..	79·3	94·1	61·3	15·6	103·48	4·85	165	405	—
1873	..	78·9	94·5	60·3	15·8	104·10	2.82	181	470	—
1872	..	78·9	97·5	59·3	15·7	127·08	5·05	180	502	—
1871	.	79·4	97·7	63·2	15·0	159·51	14·95	180	—	—
Seven Years	..	79·1	97·7	56·3	15·8	113·24	14·95	156	438*	—

* Six years mean.

NOTES ON 1877:—

Extreme range of temperature in shade for the year was 41·3, or from 97·6 on 9th December to 56·3 on 14th September.

Highest mean temperature for any twenty-four hours, 88·1 on 9th December.

Lowest mean temperature for any twenty-four hours, 69·2 on 9th August.

Greatest daily range, 30·6 on October 9th.

Least daily range, 2·4 on March 31st.

The mean temperature for December, 84·1, exceeds by 2·3 the highest monthly average yet registered at the station, since January, 1871.

The temperature in shade in December exceeded 90·0 every day in the month except three.

The rainfall in January exceeded the total rainfall during the remaining eleven months of the year by 2·87 inches.

In 74 hours ending 8 a.m. January 29, 27·32 inches of rain fell, causing extensive floods, but little destruction of property; this included 12·08 inches which fell in 24 hours on the 27th.

The only gale during the year occurred on March 31, from S.E., with light rain, thunder and lightning; it was not severe.

There was very little thunder or lightning during the year, particularly during the last nine months. In April thunder was heard on three days, once with lightning; in May on two days; then none till the 26th November, and 30th December.

N.B.—These results have been reduced from observations taken daily throughout the year, at 8 a.m. Thermometers by Casella. Rain gauge by Negretti and Zambra, five inch circular, fully exposed.

Further particulars of the drought which prevailed from August 11th to the close of the year:—

1877.	Direction of Wind.						Sunshine and Clouds.							
	No. of days.	S. to E.	S. to N. (by the East).	N.	W.	All round.	Days of sunshine throughout.	Three parts sunshine.	Two parts sunshine.	One part sunshine.	Overcast.	Rainfall in inches.	Days on which it fell.	Hours of rain.
August 11 to 31	21	18	2	1	0	0	9	2	3	5	2	0·36	3	4
September ..	30	26	1	0	1	2	14	6	4	6	0	0·41	2	3
October ..	31	21	5	3	0	2	13	7	7	3	1	1·29	4	6
November ..	30	21	9	0	0	0	15	8	4	3	0	0.48	3	4
December ..	31	18	13	0	0	0	14	10	7	0	0	0·81*	2	2
	143	104	30	4	1	4	65	33	25	17	3	3·35	14	19

* This includes 0·63 inches which fell on the 30th.

[NOTE—January 7, 1878.—During the past week only one shower of rain, equal to 0·10 inch, fell, making the total for the five months (nearly) 3·45 inches. Yesterday, January 6, temperature in shade rose to 98·6, the highest registered here in seven years.]

Wind in general blew pretty strong, but never increasing to a gale, or falling to a calm, except occasionally at night or in the early mornings.

Sun's rays in December intensely hot on some days; on the 24th, thermometer for solar radiation, by Negretti and Zambra, with blackened bulb, and placed over short grass, registered 172·0, the extreme limits of the instrument, and on the 26th 165·7.

On December 24, the salt water in a tidal creek, five feet below the surface, was 97·0; near the surface, in brackish water, 95·0.

The hygrometer gave some remarkable readings during November and December, showing, for Fiji, extreme dryness of the atmosphere:—On November 18, at 2 30 p.m., dry bulb 93·6, wet bulb 74·8, difference 18·8, deductions—dew point 63·5, tension of vapour ·586, relative humidity 37. (Complete saturation of the atmosphere being represented by 100.)

An Enumeration of recent Additions to the New Zealand Flora, with Critical and Geographical Notes. By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 2nd February*, 1878.]

Part I.—Ranunculaceæ *to* Marsilcaceæ.

Since the publication of the "Handbook of the New Zealand Flora" in 1867, numerous plants new to science have been discovered in the colony, and described from time to time in the "Transactions of the New Zealand Institute" and other scientific works. It was also found that the specific limitations of a few species were too comprehensive, so that it became necessary to separate distinct plants which had been included under one name. Further additions have resulted from the discovery of well-known species not previously observed in the colony. The descriptions of these additions being scattered through numerous volumes, has caused great inconvenience to those botanists to whom the different works are not available for reference, so that, pending the publication of a new edition of the Handbook, I have prepared the following list, with the view of obviating this inconvenience to a limited extent. It embraces all published additions of the slightest importance, so far as known to me, and I have given the fullest account of their geographical distribution; but, except in one or two special instances, I have not recorded mere alteration of names.

It is worthy of note that the additional genera not recorded in the Handbook as represented in New Zealand are but four in number: *Anguillaria, Sporadanthus, Isoëtes*, and *Pilularia*. *Sporadanthus* is the only genus new to science. *Anguillaria* belongs to Melanthaceæ, an order (or rather sub-order of Liliaceæ), not previously represented in our Flora. A similar remark applies to *Isoëtes*.

The mosses and lower cryptogams will be enumerated in a future list.

Ranunculaceæ.

Clematis **afoliata**, Buchanan; Trans. N.Z. Inst., III., p. 211.

A singular plant, at a distance presenting a close resemblance to *Carmichalia*, or the leafless form of *Rubus australis*. The young state is unknown.

North Island—Originally discovered by *Mr. Colenso*, but I am ignorant of the precise locality. South Island—Marlborough; near the site of the Wai-au-ua Bridge, Canterbury; Canterbury Plains; Waitaki, Otago.

Ranunculus lappaceus, Sm., var. **nanus.**

R. nanus, Hook.

Stem short, stout; leaves depressed, spreading, hairy or nearly glabrous, 3–5 lobed or partite lobes, cut, and waved; petioles short, broad; flowers sessile, or on a very short scape.

Sub-alpine localities in Otago, *J. Buchanan ! D. Petrie !*

Ranunculus plebeius, Br., var. *hirtus.*

R. hirtus, Banks and Sol.

This plant differs widely from the typical form, and is readily distinguished by its few leaves, which are often only lobulate, its stem sparingly branched, branches spreading and almost leafless, and its distant narrow petals, which give the flower a rayed appearance, very different to the cup-shaped flower of the type. The whole plant is usually of a rufous hue. There are two well-marked varieties:

α. stricta. Stems erect.

β. **stolonifera.** Stems procumbent, and rooting at the nodes.

a. Common throughout the colony.

b. South Island—Valley of the Dart, Otago.

Ranunculus **ternatifolius,** Kirk.

R. trilobatus, Kirk. Trans. N.Z. Inst., IX., p. 547, not of Kit.

South Island—Near Dunedin, and Catlin River, Otago.

Ranunculus **limosella,** F. Müeller, MS.; Kirk in Trans. N.Z.I., III., p. 177.

R. limoselloides, F. Müeller; Ic. Pl., t. 1081.

A singular species, distinguished by the quaternary arrangement of the parts of the flower, and the elongated sepals. Often growing in water six to ten feet deep, but only flowering in situations left dry in summer. One of the most minute flowering plants in the colony.

North Island—Whangape, Waikare, and Waihi Lakes, Lower Waikato.

South Island—Lake Pearson, 2,500ft.

VIOLARIEÆ.

Hymenanthera **latifolia,** Br., var. **chathamica.**

North Island—Upper Rangitikei, Dr. Hector ! Chatham Islands.

var. **tasmanica.**

A bush or straggling shrub 2–12 feet high; leaves obovate, 2–3 inches long, narrowed into stout petioles, distantly crenate or serrate; flowers in axillary fascicles.

North Island—Great Barrier Island and adjacent islets; Little Barrier Island; Waiheki Island.

PITTOSPOREÆ.

Pittosporum **huttonianum,** Kirk; Trans. N.Z. Inst., II., p. 92, IV., p. 268.

North Island—Whangarei; Great Barrier Island; Thames Goldfield.

Pittosporum **kirkii**, Hook. f., MS.; Kirk, Trans. N.Z. Inst., IV., p. 264.
North Island—Whangarei to Thames Goldfield, but very local; Great Barrier Island.

Pittosporum umbellatum, Banks and Sol., var. **cordatum**. Trans. N.Z. Inst., IV., p. 264.
North Island—Great Barrier Island.

Pittosporum **virgatum**, Kirk; Trans. N.Z. Inst., III., p. 161.
North Island—Whangaroa (North); Great Barrier Island.

Pittosporum **ralphii**, Kirk; Trans. N.Z. Inst., III., p. 161.
North Island—Patea; Great Barrier Island.

Pittosporum "**intermedium**," Kirk; Trans. N.Z. Inst., IV., p. 266.
North Island—Kawau.

Pittosporum **ellipticum**, Kirk; Trans. N.Z. Inst., IV., p. 266.
Sub-species **ovatum**.
North Island—"*ellipticum*," Manaia Hills; "*ovatum*," Whangaroa (North); Titirangi.

MALVACEÆ.

Hibiscus **diversifolius**, Jacq.; Kirk, Trans. N.Z. Inst., III., p. 163.
North Island—Spirits Bay; near Wanganui, etc.

TILIACEÆ.

Aristotelia **erecta**, Buchanan; Trans. N.Z. Inst., III., p. 209.
I have not seen specimens.
North Island—Patea.
South Island—Wyndham; Lake District, Otago.

RUTACEÆ.

Melicope ternata, Forst., var. **mantellii**.
M. mantellii, Buchanan; Trans. N.Z. Inst., III., p. 212.

This plant appears to be a hybrid between *M. ternata* and *M. simplex*; it is usually found in situations where both species occur, and presents the characters of both in varying degrees: on the whole the foliage approaches more closely to *M. ternata*: the inflorescence to *M. simplex*.

North Island—Auckland; Thames Goldfield; common about Wellington.

ROSACEÆ.

Rubus australis, Forst., var. **parva**.
R. parva, J. Buchanan; Trans. N.Z. Inst., VI., p. 243, pl. XXII., figs. 2 and 3.

Whole plant of a peculiar bronzed hue, stems from a few inches to several feet in length; leaves often reduced to a single leaflet; panicle few-flowered. In its most diminutive form this plant departs widely from the type, but not to a greater extent than other varieties.

South Island—Lower part of the Otira Valley; Brunner Paddock; Inangahua Valley.

Geum **uniflorum**, J. Buchanan; Trans. N.Z. Inst., II., p. 89.
A very distinct species.
South Island—Discovery Peaks.

Acæna **novæ-zelandiæ**, Kirk; Trans. N.Z. Inst., III., p. 117.
In both islands, not uncommon.

Acæna **depressa**, Kirk; Trans. N.Z. Inst., IX., p. 548.
Allied to *A. buchanani*, Hook. f.
South Island—Cardrona Valley; Lake Hawea, Otago.

Acæna **glabra**, J. Buchanan; Trans. N.Z. Inst., IV., p. 226.
South Island—Marlborough to Otago; not unfrequent in the mountains, 2,000–4,000 feet.

HALORAGEÆ.

Haloragis **aggregata**, J. Buchanan; Trans. N. Z. Inst., IV., p. 224.
I fear this is too closely allied to *H. depressa*, Hook. f.
South Island—Lake Guyon, Nelson.

Haloragis **uniflora**, Kirk; Trans. N.Z. Inst., IX., p. 548.
South Island—The Bluff Hill, Southland.

ONAGRARIEÆ.

Fuchsia **kirkii**, Hook. f., Ic. Pl.; Kirk, Trans. N.Z. Inst., III., p. 178.
Procumbent; flowers erect, corolla o.
North Island—Whangururu; Great Barrier Island.

UMBELLIFERÆ.

Pozoa **pallida**, Kirk; Trans. N.Z. Inst., X., p. 419.
Allied to *P. hydrocotyloides* and *P. roughii*.
South Island—Roto Iti; Lake Guyon, Nelson; Pukunui Creek, Canterbury.

Apium **leptophyllum**, F. Müeller; Kirk, Trans. N.Z. Inst., III., p. 164.
North Island—Bay of Islands; Kawau.

Aciphylla montana, Armstrong; Trans. N.Z. Inst., IV., p. 290.
Apparently a form of *A. monroi*, Hook. f. I have not seen specimens.

Ligusticum **enysii**, Kirk; Trans. N.Z. Inst., IX., p. 548.
South Island—Broken River, Canterbury.

ARALIACEÆ.

Panax longissimum, Hook. f.

In the "Handbook of the New Zealand Flora," at p. 110, Sir Joseph Hooker described the young state of *P. crassifolium* (Dcn. and Planch.) as a distinct species under the name *P. longissimum*, the flowers and fruit of which were supposed to be unknown. The Handbook was published in two parts, with an interval of three years between; at page 730 of the second

part the author writes: "*P. longissimum*, referred to *Pseudopanax crassifolium* by Seeman (Journ. Bot., 1864). * * * Mr. Logan has sent me specimens clearly showing that it is the young state of *Panax crassifolium*." With the opinion thus expressed by Seeman, and confirmed by the author of the "species," I entirely agree.

Mr. Buchanan, however, does not accept this opinion, but in Trans. N.Z. Inst., vol. IX., p. 529, has applied the name "*longissimum*" to the typical *P. crassifolium*, and under the name "*crassifolium*" has, in part at least, described a totally distinct plant. While I fully agree with him in considering that more than one species has been confused under *P.* "*crassifolium*" (Den. and Planch.), it is with regret that I find myself unable to adopt either of his conclusions—1st, because Hooker's *P. longissimum* is, as stated by him, clearly identical with *P. crassifolium* (Den. and Planch.); 2nd, Buchanan's *P. crassifolium* consists of two species—the trifoliolate state of the true plant mixed with a totally different plant, one, moreover, quite unknown to Banks and Solander.

1st. That Hooker's *P. longissimum* is identical with the true *P. crassifolium* might be taken for granted on his own statement already quoted, but as confirming it, I may point out that, although in Fl. Nov.-Zel. (I., p. 96), the leaves of the young plant of *Aralia crassifolia* are correctly described as simple and remotely toothed, in the Handbook all description of leaves of this form is omitted under *P. crassifolium*, and the simple linear form of leaf is transferred bodily to *P. longissimum*, so that the description of the leaves of *P. crassifolium* commences with the second or trifoliolate stage. Further, both plants are expressly said to be common throughout the colony.

2nd. It is still more easy to show that Mr. Buchanan's *P. crassifolium* is not the plant of Banks and Solander (except with regard to the trifoliolate leaves which have no connection with the young, simple leaves, and the mature fruited state with which he has associated them).

The young leaves of his plant are as shown by his drawing (Plate XX.) irregularly lobulate-dentate, with stout hooked teeth capable of inflicting a nasty wound if incautiously handled; a peculiar character, differing widely from the true plant, and which would not have escaped the notice of Banks and Solander. Moreover, they are never succeeded by trifoliolate leaves; those described by him, and preserved in the Colonial Herbarium, belong to the true plant (his *P. longissimum*), and to that alone, as is evident from their texture. Again, the umbels of *P. crassifolium* are described by Hooker as "composed of several very spreading rays." In Mr. Buchanan's plate (XX.), which represents the staminate plant, the umbel consists of nearly simple racemes, and in the pistillate plant is remarkably compact, consisting of simple 1–3-flowered rays.

Moreover, the original specimens of Banks and Solander were collected in the North Island, while Mr. Buchanan's plant is confined to the South Island, where it is extremely local and is not known to occur in any of the localities visited by Captain Cook.

Mr. Buchanan bases his identification chiefly upon Hooker's description of the fruit of *P. crassifolium* as 5-celled, but this is easily explained by the fact that there are two or more forms of true *P. crassifolium*, one of which is characterized by 5-celled fruit, the other by 4-celled. Further, there is reason to believe that the young ovaries are nearly always 5-celled; one or more cells becoming suppressed at an early stage of growth.

The following is a summary of our present knowledge of the forms included by authors under *P.* "*crassifolium*":—

1. *P. crassifolium*, Dcn. and Planch.; Hook. f., "Handbook of New Zealand Flora," p. 101. *P. longissimum*, Hook. f., ib. p. 102; Buchanan, Trans. N.Z. Inst., IX., p. 530, pl. XXI. *Aralia crassifolia*, Banks and Sol.; Fl. N.Z., p. 96.

A small diœcious tree 20–35 feet high; leaves di- or tri-morphic; on young plants up to 15 feet high, simple, linear, rigid, coriaceous, 12–30 inches long, spreading or drooping so that the under surface forms an acute angle with the stem, remotely or sinuately toothed, narrowed into a short, stout petiole, purplish below, brownish-green above, with more or less irregular pale blotches; abruptly passing into 3-foliolate leaves, of which the petioles are about 3 inches; leaflets 3–6 inches, at first resembling the early leaves but less coriaceous, ¼–½-inch wide, with bold, distant, somewhat falcate teeth; gradually passing into wider, more coriaceous forms, with ordinary serratures more or less distant; ultimately succeeded by the mature unfoliolate state, lanceolate, oblanceolate, or obovate, 3-7 inches long, 1–1½ inches wide, narrowed into stout petioles ½–1-inch long, with few serratures, or quite entire. Umbels terminal, compound, primary rays about 8, 2–3 inches long, ultimate rays 4–6, sub-racemose or umbellate, flowers on short pedicels. Male petals 5, stamens 5, abortive ovaries with 5 styles. Female, ovary 5- or 4-celled, styles 5 or 4, connate at the base, tips barely free; fruit globose 5- or 4-celled.

Of this we have at least two principal forms.

α. *crassifolia vera*. Leaves trimorphic, leaflets of trifoliolate and mature leaves jointed to the petiole; flowers produced both in the 3-foliolate and ultimate stages; ripe fruit nearly ¾ of an inch in diameter.

β. Leaves dimorphic, never trifoliolate, not obviously jointed to the petiole, fruit more densely crowded than in α and smaller.

There are two sub-varieties.

a. Ultimate rays of female umbels sub-racemose, ovaries 5-celled.

b. Ultimate rays of female umbels umbellate, ovaries usually 4-celled.

This character, however, is not absolute, as both 4- and 5-celled ovaries may occasionally be found on the same ray. It is, however, certain that in many cases 5-celled ovaries become 4-celled by suppression at a very early stage.

I have seen no ripe fruit so small as the specimen figured by Mr. Buchanan on Plate XXI.

At Mungaroa I collected specimens of the early leaves of variety β, which measured 43 inches in length.

Var. α appears to be local; I have observed it only in the Auckland district. Mr. Buchanan finds it near Dunedin.

Var. β is probably common throughout the colony, except in the Auckland district, where, I believe, it has not been observed. Both sub-varieties may be found side-by-side about Wellington, flowering in February and March.

A plant common in the Inangahua Valley and other parts of the interior of the South Island is probably different from either of the above; the early leaves, while retaining their elongated form, gradually lose their teeth and their bronzed hue, assuming the green, glossy texture of the mature leaves, which, in their turn, are more decidedly lanceolate, less serrate, and rather more membranous than in any North Island form. Inflorescence in large compound umbels, only seen in bud. Fruit unknown.

2. *P.* **ferox,** MS.

P. longissimum, Buchanan; Trans. N.Z. Inst., IX., p. 530, pl. XX. (Leaf of young plant and male umbel); not of Hook. f.

A small diœcious tree about 20 feet high; leaves dimorphic, simple in all stages; on young plants linear, 12–18 inches long, drooping, resembling the early state of *P. crassifolium*, but much more rigid and coriaceous, irregularly lobulate-dentate, teeth stout, hooked, acute; mature leaves excessively thick and coriaceous, 3–5 inches long, $\frac{1}{4}$–$\frac{3}{8}$ of an inch broad, linear obovate, apiculate, gradually narrowed to the base, forming a short petiole; umbels terminal; male of 6–10 simple rays, flowers pedicelled, sub-racemose, stamens 4; female, compact, of 6–9, 1–3-flowered rays about 1-inch long; fruit ovoid 5-celled, calycine ring strongly marked, styles 5, connate into a column, tips scarcely recurved.

Hab. South Island—Near Nelson, Dr. Hector and T. Kirk; Valley of the Buller, near the junction of the Matukituki, T.K.; common near Dunedin, Mr. Buchanan! (male flowers only).

My first knowledge of this plant was obtained in 1873, when it was collected by Dr. Hector and myself near Nelson, but the specimens were not in sufficiently good condition to allow of a diagnosis being drawn. I have not seen either male or female flowers in a perfect condition, so that the description must be considered as provisional.

Mr. Buchanan states that this plant is common near Dunedin and Nelson: he must have been misinformed as to its frequency about Nelson, since it is remarkably local in that district, and occurs but sparingly.

Panax lessonii, DC., var. **heterophylla**; Trans. N.Z. Inst., I., p. 142, (edition 1.)

Leaves dimorphic; on old plants unifoliolate, ovate-acuminate, petioles 1–2 inches long, lamina 1½–2 inches, and trifoliolate, on petioles 3 inches long, leaflets sessile, ovate-lanceolate, or ovate-acuminate; fruit as in the typical form.

North Island—Whangaroa (North).

Panax **discolor**, Kirk; Trans. N.Z. Inst., III., p. 178.

A diœcious species allied to *P. lessonii*, DC., styles 5.

In the catalogue of northern plants published in the 2nd Volume of "Transactions of the New Zealand Institute," (p. 243), Mr. Buchanan has referred this plant to *P. simplex*, which does not occur north of the Hauraki Gulf.

North Island — Whangaroa (North); Great Omaha; Great Barrier Island; Little Barrier Island; Cape Colville; Thames Goldfield.

LORANTHACEÆ.

Loranthus **decussatus**, Kirk; Trans. N.Z. Inst., III., p. 162.

North Island—Cape Colville Peninsula; Titirangi. South Island—From Nelson to Otago.

RUBIACEÆ.

Coprosma **arborea**, Kirk; Trans. N.Z. Inst., X., p. 420.

North Island—From North Cape to Hauraki Gulf; Waiheki Island.

Coprosma **serrulata**, Hook. f., MS.; Buchanan, Trans. N.Z. Inst., III., p. 212.

A very distinct robust species 1–2 feet high; bark white and papery on old branches; interpetiolar stipules very large, ciliated when young; male flowers axillary, solitary, or in 2-3-flowered fascicles, sessile or nearly so; calyx cleft nearly to the base, lobes broad; corolla not seen; female flowers (specimen very imperfect) apparently solitary, sessile. The margin of the leaf is shortly lacerate rather than serrulate. The young leaves of *C. robusta* are truly serrulate.

South Island—Mountain districts, Marlborough to Otago, 2,000–4,000 feet.

COMPOSITÆ.

Olearia nitida, Hook. f., var. **capillaris.**

O. capillaris, Buch.; Trans. N.Z. Inst., III., p. 212.

South Island—Nelson Mountains, 4,000 feet.

Mr. Buchanan agrees with me in considering this a variety of *O. nitida.*

Olearia **excorticata,** Buch.; Trans. N.Z. Inst., VI., p. 241.

"Allied to *O. lacunosa*, Hook. f., in flowers and fruit," *Buchanan.* I have not seen specimens.

North Island—Tararua Mountains.

Olearia **allomii,** Kirk; Trans. N.Z. Inst., III., p. 179.

A very distinct species, allied to *O. haastii*, Hook. f.

North Island—Great Barrier Island, 800–2,800 feet.

Celmisia **lateralis,** Buchanan; Trans. N.Z. Inst., IV., p. 226, pl. XV.

A distinct species allied to *C. laricifolia*, Hook. f., but with lateral flowers.

South Island—Mountains near Lake Guyon, Amuri.

Celmisia **walkeri,** Kirk; Trans. N.Z. Inst., IX., p. 549, pl. XXX.

A strongly-marked species; distinguished by its woody stems, patent leaves, and lateral flowers.

South Island—Mountains above Lake Harris, Otago, 4,000 feet.

Ozothamnus **lanceolatus,** Buchanan; Trans. N.Z. Inst., II., p. 88.

Allied to *O. glomeratus*, Banks and Sol.

North Island—Maungatauiwha.

Raoulia **petriensis,** Kirk; Trans. N.Z. Inst., IX., p. 549.

Allied to *R. hectori*, Hook. f.

South Island—Mount St. Bathans, Otago.

Gnaphalium **fasciculatum,** Buchanan; Trans. N.Z. Inst., IX., p. 529, pl. XIX.

Allied to *G. youngii*, Hook. f.

North Island—Tararua Mountains.

Erechtites **glabrescens,** Kirk; Trans. N.Z. Inst., IX., p. 550.

Allied to *E. scaberula*, Hook. f., but never scabrid.

South Island—In subalpine woods, etc., Nelson to Otago; Stewart Island.

Senecio **"pottsii,"** Armstrong; Trans. N.Z. Inst., IV., p. 290.

Mr. Armstrong states that his specimens were "very imperfect, but that the plant differs from any other New Zealand species in the suffruticose

habit and solitary heads." I have not seen specimens, but suspect it to be an alpine state of some well-known species.

South Island—Mount Jollie, Rangitata, 4,500 feet.

Senecio **hectori**, Buchanan; Trans. N.Z. Inst., V., p. 348, VI., pl. XXIII.

A noble plant allied to *S. glastifolius*, Hook. f., but of widely different habit and foliage.

South Island—Valley of the Buller, between Rotorua and the Inangahua, frequent; Valley of the Grey.

Senecio **myrianthos**, T. F. Cheeseman; Trans. N.Z. Inst., VII., p. 348.

S. cheesemannii, Hook. f., Ic. Pl., t. 1,201.

A handsome species allied to *S. perdicioides*, Hook. f., and *S. sciadophilus*, Hook. f.

North Island—Thames Goldfield.

Senecio **laxiflorus**, Buchanan, MS.

S. laxifolius; Trans. N.Z. Inst., II., p. 89.

Mr. Buchanan informs me that "*laxifolius*" was substituted for "*laxiflorus*" through a printer's blunder. I have adopted his original name, as that printed is singularly inappropriate.

Closely allied to *S. greyii*, Col., but differing in the lax open panicle.

South Island—Fowler's Pass, 3,000–3,500 feet.

Senecio **robusta**, Buchanan; Trans. N.Z. Inst., VI., p. 240, pl. XXIII., f. 1.

A very distinct species allied to *S. bidwillii*, Hook. f., but the leaves are scarcely coriaceous, and the corymbs are usually many-flowered. When fresh the whole plant is extremely viscid.

South Island—Mount Eglinton, *J. Morton!* Mountains above the Greenstone, *J. Buchanan;* Mountains above Lake Harris, 4,000 feet, *T. Kirk.*

CAMPANULACEÆ.

Selliera fasciculata, J. Buchanan; Trans. N.Z. Inst., III., p. 211; is merely a rupestral form of *S. radicans*, Car.

JASMINEÆ.

Olea apetala, Vahl.; Kirk, Trans. N.Z. Inst., III., p. 165.

North Island—Rocky places near the sea; Tauranga Islands; Great Barrier Island; Nelson Island; Little Barrier Island.

GENTIANEÆ.

Gentiana novæ-zelandiæ, Armstrong; Trans. N.Z. Inst., IV., p. 291.

Appears to be only a trivial variety of *G. montana*, Forst.

CONVOLVULACEÆ.

Dichondra repens, Forst., var. **brevifolia.**

D. brevifolia, J. Buchanan; Trans. N.Z. Inst., III., p. 208.

Differs from the typical form only in its small size and elongated peduncles.

North Island—In turfy bogs, Papatoitoi. South Island—Poputunoa and other places, Otago.

SCROPHULARINEÆ.

Mimulus repens, Br., var. **colensoi.**

M. colensoi, Kirk; Trans. N.Z. Inst., III., p. 179.

I am unable to maintain this as a distinct species, notwithstanding its apparent divergence from the typical form.

North Island—Onehunga.

Gratiola peruviana, R. Br. (*G. sexdentata*, A. Cunn.)

β. **latifolia.**

G. latifolia, R. Br.; Kirk, Trans. N.Z. Inst., III., p. 165.

γ. **pumila**; F. Muell., Linnæa, XXV., p. 481.

Leaves small, narrow, glabrous, or viscid pubescent.

North Island—β. Mangawhare; γ. Auckland.

Veronica arborea, Vahl., var. **arborea.**

V. arborea, J. Buchanan; Trans. N.Z. Inst., VI., p. 212.

North Island—Great Barrier Island; Cape Terawiti, etc.

Mr. Buchanan states the trunk is 3 feet in diameter; but the largest specimen I have seen would scarcely be more than 8 feet in circumference.

Veronica chathamica, J. Buchanan; Trans. N.Z. Inst., VII., p. 338, pl. XIII., f. 1.

A distinct species with wiry procumbent stems; racemes puberulous, capsules longer than the calyx, narrowed at both ends.

Not agreeing in habit with any other of the fruticose species, but approaching *V. ligustrifolia* and *V. parviflora* in the racemes, calyx, and capsule. The racemes become elongated and lose the early obtuse character so well shown in Mr. Buchanan's drawing.

Chatham Islands.

Veronica vernicosa, Hook., f., var. **anomala.**

V. anomala, Armstrong; Trans. N.Z. Inst., IV., p. 291.

A plant of this abnormal form kindly given me by Mr. Armstrong, flowered at midsummer after three years' cultivation, and presented characters somewhat at variance with those in the original description.

Flowers, sessile, in 1–3 terminal, 5–10-flowered spikes; sepals 3, obtuse; tube of corolla elongated, segments usually 3 (rarely 4), spreading narrow; stamens 2; capsule slightly turgid, and rarely exceeding the calyx.

This singular variety has more the appearance of a casual "sport" than a permanent form. It differs from the type in its more slender branchlets, and the brownish-green hue of its more distant leaves.

South Island—Head-waters of the Rakaia.

Mr. Armstrong agrees with me in considering this a form of *V. vernicosa*, Hook. f.

Veronica **obovata**, Kirk; Trans. N.Z. Inst., IX., p. 502.

Allied to *V. lævis*, but very different in habit and leaves.

South Island—Broken River, Canterbury.

Veronica **canescens**, Kirk; Trans. N.Z. Inst., IX., p. 503.

The only New Zealand species with solitary, axillary flowers.

South Island—Lake Lyndon, Canterbury, 2,800 feet; Oamaru, Otago.

POLYGONEÆ.

Rumex **neglectus**, Kirk; Trans. N.Z. Inst., IX., p. 493, Ic. Pl., t. 1,245.

North Island—Shingly beaches, Cook Strait. South Island—Dusky Bay; Bluff Harbour.

CHENOPODIACEÆ.

Chenopodium **detestans**, Kirk; Trans. N.Z. Inst., IX., p. 550.

South Island—Between Lake Lyndon and the Cass River, Canterbury; outlet of Lake Hawea, Otago.

CONIFERÆ.

Dacrydium **intermedium**, Kirk; Trans. N.Z. Inst., X., p. 386, pl. XX.

North Island—Great Barrier Island; Cape Colville; Thames Goldfield; Tongariro. South Island—Dun Mountain, between Greymouth and Okarita.

Dacrydium **westlandicum**, Kirk; Hook. f., Ic. Pl., t. 1,218; Trans. N.Z. Inst., X., p. 387, pl. XVIII.

North Island—Great Barrier Island and Whangaroa; (identified from young plants only.) South Island—West Coast, from Greymouth to Okarita, etc., etc.

Dacrydium **bidwillii**, Kirk; Trans. N.Z. Inst., X., p. 388.

South Island—*α. erecta:* Nelson; Canterbury; West Coast to Dusky Bay. *β. reclinata:* Nelson, by the Thomas River; Upper Waimakariri; Arthur's Pass, Canterbury; West Coast of Otago.

Dacrydium **kirkii**, F. Müeller in De Candolle's Prod., vol. XVI., pars. 2, p. 495; Hook. f., Ic. Pl., t. 1,219; Trans. N.Z. Inst., X., p. 390, pl. XIX.

North Island—Whangaroa (North) to Manukau, but local; Great Barrier Island.

Phyllocladus **glauca**, Carriere, Coniferes, p. 502; Trans. N.Z. Inst., X., p. 380.

North Island—Hokianga to Wairoa (East), and Thames Goldfield, but local; Great Barrier Island.

ORCHIDACEÆ.

Corysanthes **cheesemannii**, Hook. f., Ic. Pl., t. 1,120; Kirk, Trans. N.Z. Inst., III., p. 180.

The only New Zealand species belonging to the typical section of the genus.

North Island—Titirangi; Te Whau; Remuera.

NAIADEÆ.

Potamogeton polygonifolius, Pourret; Kirk, Trans. N.Z. Inst., III., p. 165.

North Island—Great Omaha; Papakura, etc. South Island—Marlborough; Southland.

Zannichellia preissii, F. Müeller.

Lepilæna preissii, Müeller; Frag. Phyt. Aust., VIII., p. 217.

Baron v. Müeller refers the *Zannichellia palustris* of my Botany of the Waikato (Trans. N.Z. Inst., III., p. 148) to this species, characterized by the ternary arrangement of the female flowers, each with a separate bract, and of the fruit "which altogether agrees with that of *Althenia*," as well as in the cupular trilobate male perianth, and monadelphous anthers.

It is probable that we have more than one form in the colony.

Zostera nana, Roth., var. *müelleri*; Kirk, Trans. N.Z. Inst., p. 892.

Z. müelleri, Irmisch.

North Island—Port Nicholson.

LILIACEÆ.

Cordyline "**hookeri**," Kirk; Trans. N.Z. Inst., V., p. 244.

North Island—Hauraki Gulf; Ruahine Mountains; Mount Egmont; Rimutaka.

Astelia cunninghamii, Hook. f., var. **hookeriana**; Kirk, Trans. N.Z. Inst., IV., p. 244.

North Island—Little Barrier Island; near Auckland.

Astelia **grandis**, Hook. f., MS.; Kirk, Trans. N.Z. Inst., IV., p. 245.

North and South Islands—In marshy places.

Astelia **trinervia**, Kirk; Trans. N.Z. Inst., IV., p. 246.

North Island—In forests, North Cape to Taupo.

MELANTHACEÆ.

Anguillaria **novæ-zelandiæ**, Hook. f., MS.

A small bulbous herb; bulb tunicate; scape 1–2 inches high, clothed with the persistent sheathing bases of old leaves; leaves 2, narrow linear, sheathing, much longer than the scape; flower solitary, perianth leaves 6, with three raised linear bands; stamens 6; ovary trigonous, obtuse, styles recurved.

South Island—In swamps near Christchurch; Rangitata, *Mr. Armstrong.*

For my specimens of this interesting addition to our flora, I am indebted to its discoverer, Mr. Armstrong, and to Dr. von Haast. It is mentioned by Mr. Armstrong in his list of Christchurch plants, Trans. N.Z. Inst., II., p. 126, but so far as I am aware no description has yet been published.

JUNCEÆ.

Juncus glaucus, L.; Kirk, Trans. N.Z. Inst., X., p. 393.

South Island—Between Hokitika and Ross.

Juncus lamprocarpus, Ehrhart; Kirk, Trans. N.Z. Inst., VII., p. 378.

North Island—Port Nicholson. South Island—Marlborough; West Coast; Invercargill; the Bluff, etc.

Juncus **involucratus**, Kirk; Trans. N.Z. Inst., IX., p. 550.

South Island—Amuri, 3,000 feet.

Juncus **pauciflorus**, Kirk; Trans. N.Z. Inst., IX., p. 551.

South Island—Castle Hill Basin, Canterbury.

RESTIACEÆ.

Sporadanthus traversii, F. Müeller, MS.

Lepyrodia traversii, F. Müell.; Fragmenta Phytographiæ Australiæ, VIII., p. 79.

Stems glabrous, 2-4 feet high, stout, terete, smooth; branches fastigiate; sheaths distant, acuminate. Male flower, panicle terminal, elongated, fastigiate, 8-9 inches long; spikelets peduncled; outer glumes ovate-acuminate, with scarious margins; perianth segments 6, linear lanceolate, two of the outer series rather longer than the others; stamens equalling the perianth; female flower not seen; fruit a nucule (Müeller.)

Chatham Islands—*H. H. Travers!*

Baron von Müeller points out that this is doubtless the supposed *Calorophus* collected by Dieffenbach, as mentioned by Hooker; Handbook New Zealand Flora, p. 295.

Rostkovia novæ-zelandiæ, J. Buchanan; Trans. N.Z. Inst., IV., p. 227.

Mr. Buchanan and myself are agreed in referring this to *R. gracilis*, Hook. f., previously only known to occur in the Auckland islands.

CYPERACEÆ.

Cyperus **buchanani**, Kirk; *C. gracilis*, J. Buchanan in Trans. N.Z. Inst., p. 210; not of R. Brown.

Culms 1–2 feet high, trigonous; leaves flaccid, shorter than the culms, keeled, margins smooth; involucre of 3–6 spreading grassy leaves, 3–6 inches long; umbels of 4–8 unequal rays, 1–4 inches long, usually compact; spikelets ½–¼-inch long, sessile, arranged in involucellate 6–12-rayed umbels

or fascicles, and densely crowded near the tips of the primary rays; glumes 10–15 on each side, broadly lanceolate, acute; stigmas 3; nut triquetrous.

At once distinguished from *C. ustulatus* by its flaccid slender leaves and rounded heads. The spikelets are sessile, but assume a pedicellate appearance from the falling away of the lower glumes.

North Island—Hutt Valley; especially plentiful by the Waiwetu River.

Schœnus **vacillans**, Kirk; Trans. N.Z. Inst., X., p. 421.

North Island—Cape Colville.

Isolepis "**globosa**," J. Buchanan; Trans. N.Z. Inst., III., p. 211.

The spikelet varies greatly in size and form, from $\frac{1}{8}$–$\frac{3}{4}$ of an inch in length, and from ovoid to linear; small states cannot be distinguished from ordinary *I. prolifer*, Br.; for, although Mr. Buchanan gives the smooth nut as a differential character, I have never seen New Zealand specimens of *I. prolifer* with dotted nuts. I am uncertain as to the propriety of considering one or two of the series of forms included under *I. prolifer* as distinct plants, or as varieties of one protean species—the present amongst them.

North Island—About Wellington.

Isolepis fluitans, Br.; *Scirpus fluitans*, L., Kirk, Trans. N.Z. Inst., III., p. 166.

North Island—Mangatawhiri Creek; lakes and streams in Waikato.

South Island—The Bluff Hill (a doubtful identification.)

Cladium **huttoni**, Kirk; Trans. N.Z. Inst., IX., p. 551.

Allied to *C. glomerata*, Br., but distinguished by its drooping habit, open panicle, and small florets.

North Island—Lakes in the Lower Waikato; Tikitapu Lake, Taupo.

Gahnia **rigida**, Kirk; Trans. N.Z. Inst., IX., p. 551.

Allied to *G. setifolia*, Hook. f.

South Island—West Coast, in several localities between Greymouth and Okarita.

Gahnia **hectori**, Kirk; Trans. N.Z. Inst., IX., p. 551.

A very distinct species, allied to *G. procera*, Forst.

North and South Islands—As far south as Okarita.

Carex chlorantha, Brown; Prodromus, 242.

A small rather stout species, culms 3–6 inches high, rigid; leaves shorter than the culms; spike compact, oblong, of 5–8 oval androgynous spikelets, bract short; male flowers below, crowded; stamens 3; glumes ovate-acuminate, utricle pyriform, margins serrulate; stigmas 2.

North Island—Waitemata.

GRAMINEÆ.

Danthonia raoulii, Steudel, var. **australis**; J. Buchanan, Trans. N.Z. Inst., IV., p. 224.

South Island—Kaikoura Mountains; Lake Guyon, Nelson.

Danthonia semi-annularis, Br., **alpina**; J. Buchanan, Trans. N.Z. Inst., IV., p. 225.

South Island—Wairau Valley; Amuri 3,000–5,000 feet; Dusky Bay.

A remarkable plant, seldom flowering; most probably a distinct species.

Arundo conspicua, Forst., var. **fulvida.**

A. fulvida, J. Buchanan; Trans. N.Z. Inst., p. 242.

North Island—Poverty Bay; Port Nicholson. South Island—Mataura River, Otago.

FILICES.

Dicksonia antarctica, Br., var. *fibrosa.*

D. fibrosa, Col. in Tasmanian Journal; Baker in Synopsis Filicum (2nd edit.), p. 461.

This differs from ordinary forms of the Australian and Tasmanian plant, in its smaller size, hairy rachis, more compact habit, and less coriaceous texture, but these are not characters on which specific distinctions can be based, so that I am unable to accept Mr. Baker's opinion as to its specific validity. See Sir Joseph Hooker's emphatic remarks on this species, Fl. N.Z., II., p. 10.

Hymenophyllum **cheesemannii**, Baker, Synopsis Filicum (2nd edition), p. 464; Cheeseman, Trans. N.Z. Inst., VIII., p. 329.

North Island — Amongst moss on trees, Whangarei; Great Barrier Island; Titirangi; Hunua; Thames Goldfield.

Hymenophyllum **armstrongii**, Kirk.

Trichomanes armstrongii, Baker, Syn. Fil. (2nd edit.), p. 464; Armstrong, Trans. N.Z. Inst., IV., p. 291; Kirk, Trans. N.Z. Inst., X., pl. XXI. A. also p. 592.

This minute plant is a true *Hymenophyllum*, the involucres being distinctly 2-valved and divided to the base when mature. They are much compressed, especially in the young state, and the lips have a broad margin, but there is no constriction; occasionally the lips of the valves are slightly recurved after the discharge of the spores. It can only be distinguished from *H. cheesemannii* by the stout marginal nerve and firmer texture; the involucres are not constantly ciliated.

It forms matted patches on rocks, or occurs more sparingly amongst moss on trees, so that, like the preceding, it is easily overlooked.

Plate XXI. A., 1 and 2, *Hymenophyllum armstrongii*, natural size; 3, fertile pinna, enlarged; 4 and 5, sori, greatly enlarged.

South Island—On rocks, Upper Waimakariri; Bealey; Arthur's Pass; on trees, Hokitika; Okarita; sea-level to 4,000 feet. I am indebted to *Mr. A. Hamilton* for my knowledge of its occurrence at Okarita.

Hymenophyllum villosum, Colenso; Kirk, Trans. N.Z. Inst., X., p. 395.

North Island — Ruatahina; Tarawera. South Island — From Marlborough to Otago, 2,000-4,000 feet.

Hymenophyllum **montanum**, Kirk; Trans. N.Z. Inst., X., p. 394, pl. XXI. B.

South Island—Lake Wakatipu.

Davallia **forsteri**, Carruthers; Baker in Syn. Fil. (2nd edit.), p. 470.

"Allied to *D. scoparia*, but with the sori smaller and bordered." (Baker.) Only known from Forster's original specimen in the British Museum.

South Island—Dusky Bay.

Lindsaya viridis, Colenso, Tasmanian Journal; Baker, Journal of Botany, vol. IV. (1875), p. 108; Kirk, Trans. N.Z. Inst., X., p. 396.

North Island—Port Fitzroy; Manukau; Te Whau; Mangarewa; Wanganui. South Island—Massacre Bay; Hokitika; West Coast of Otago.

Dr. von Haast informs me that he has never collected this species in Canterbury, so that there can be no doubt that the specimens labelled "Canterbury, *Sinclair and Haast*," in the Kew Herbarium, were obtained by Sinclair in the North Island.

Cheilanthes tenuifolia, Swartz; Kirk, Trans. N.Z. Inst., VI., p. 247.

Apparently confused with *C. sieberi*, Kunze, by New Zealand collectors, but distinguished by the triangular or rhomboid frond.

North Island—Mr. Colenso informs me that he has collected it in the Hawke Bay district. South Island—Lyttelton Harbour; mountains about Queenstown; Lake Hawea, abundant.

Lomaria duplicata, Potts; Trans. N.Z. Inst., IX., p. 391.

This is merely a branched form of *L. procera*, var. *minor*, but remarkable for its constancy. Mr. Potts points out that simple and branched fronds are produced on the same plant.

Lomaria **acuminata**, Baker; Syn. Fil. (edit. 2), p. 481.

Intermediate between *L. attenuata*, Willd., and *L. lanceolata*, Spreng.

Kermadec Islands.

Doodia media, R. Br., var. **milnei**.

Baker in Syn. Fil. (2nd edit.), p. 482.

D. milnei, Carr.; Fl. Viti, p. 352.

Kermadec Islands.

Nephrodium glabellum, A. Cunn; Kirk, Trans. N.Z. Inst., X., p. 398. *N.*

pentangularum, Col.

This species has been confused with *N. decompositum*, Br., and *N. velutinum*, Hook.

Not uncommon.

ISOETEÆ.

Isoetes **kirkii**, A. Braun, Auszug aus dem Monatsbericht Königlichen Academie der Wissenschaften zu Berlin, Juli, 1869; Kirk, Trans. N.Z. Inst., II., p. 107, pl. VII.

Resembling weak specimens of the European *I. lacustris*, but more closely-allied to the Australian *I. müelleri* (A. Braun.)

North Island—Whangape, Waikare, and Waihi Lakes, Lower Waikato; Rotokakahi, Taupo.

Isoetes **alpinus**, Kirk; Trans. N.Z. Inst., VII., p. 377, pl. XXV.

At once distinguished from *I. kirkii* by its large size, robust habit, deeper colour, and larger macrospores.

South Island—Roto Iti, Rotorua, and Lake Guyon, Nelson; Lake Lyndon, Lake Pearson, Lake Grassmere, and Lake Windermere, Canterbury, 2,000-3,000 feet.

MARSILEACEÆ.

Pilularia **novæ-zelandiæ**, Kirk; Trans. N.Z. Inst., IX., p. 547, pl. XXIX.

Allied to *P. novæ-hollandiæ*, A. Braun.

South Island—Lake Pearson and Lake Lyndon, Canterbury, 2,000-2,800 feet.

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